8. ECOLOGICAL RISK ASSESSMENT

8.1 SERA PROCESS

The SERA assesses the risks to ecological receptors from exposure to chemicals present at AA 3, former MCAS El Toro, California. The SERA was conducted according to the screening-level guidance presented in the EPA Ecological *Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (EPA 1997b) and the *Final Work Plan Removal Site Evaluation, Anomaly Area* 3 (Earth Tech 2002a) finalized in August 2002.

8.1.1 Objectives

The purpose of this section is to present the results of Tier 1, Steps 1 and 2 of the SERA conducted at AA 3 and to provide a basis for follow-on BERA steps (Tier 2, Step 3a). A draft version of the BERA is also provided in Section 8.4.

The approach of the SERA was essentially in accordance with the RSE Work Plan (Earth Tech 2002a); however, certain terminologies, sequence of screening steps and selection of representative species have been revised and/or updated in response to EPA Region IX comments on the draft SERA (Earth Tech 2003a) conducted for this site and the ERAs conducted for other sites at former MCAS El Toro. The responses to both sets of Region IX comments are presented in Appendix L10.

8.1.2 Navy and EPA ERA Process

A full ERA is an eight-step process. It is organized around the framework suggested by the EPA Risk Assessment Forum (EPA 1998a). The presentation of the SERA has been structured according to U.S. Navy policy (DoN 1999) and it fulfills both the requirements of an EPA SERA (Figure 8-1) and a U.S. Navy Tier 1 ERA (Figure 8-2). The tiered approach is framed so that it facilitates (1) frequent interactions and concurrence among the Navy and regulatory agencies, (2) risk management decisions at each specific decision point and provides criteria for exiting from or proceeding with the assessment, (3) consistency with the EPA Superfund Guidance (EPA 1997b), and (4) consistency and integration with the Navy IRP.

The Navy Tier 1 SERA uses existing data and conservative assumptions regarding contaminant exposure in a two-step process to determine if additional ERA work is warranted for the site. The process represents a screening-level ERA and can be described in two steps (Figure 8-3). Step 1 is equivalent to Step 1 of the EPA ERA process (Figure 2-1) and includes a site description, habitat assessment, pathway identification/problem formulation, and toxicity evaluation. The goal of this step is to describe the ecological setting of the site and to determine whether complete ecological exposure pathways are present. Step 2 of the Navy Tier 1 ERA process is equivalent to Step 2 of EPA ERA process. First, exposure is estimated based on conservative assumptions. Then, risk is estimated by comparing the media-specific EPCs to conservative, screening-level, media-specific benchmark values. At this point, a scientific management decision point (SMDP) is made to determine if the exit criteria for Tier 1, Step 2 have been met. These criteria are as follows:

1. There is adequate information to conclude that ecological risks are negligible and therefore there is no need for additional assessment or remediation on the basis of ecological risk
2. The information is not adequate to make a decision at this point, and the ERA process will continue to Step 3
3. The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted

8.1.3 Documentation

Per Navy policy, the Tier 1 SERA will include two components: (1) documentation of all discussions, negotiations, and subsequent concurrence among the Navy and the regulators and (2) a SERA report.

For the AA 3 SERA, an initial line of communication with the regulators was established when the draft RSE work plan, including the proposed SERA process (in accordance with the EPA and Navy protocols) for the site was submitted to the regulators for review and comments. After their review comments were addressed, a final work plan was issued. The SERA that is presented in this report was conducted in accordance with the BCT-concurred Final RSE Work Plan (Earth Tech 2002a).

A *Draft Screening Ecological Risk Assessment, Removal Site Evaluation, Anomaly Area 3* (Earth Tech 2003a) was submitted to the BCT on 13 May 2003 for their review and comment. The report presented the representative species selected for the site and the exposure parameters that were used for the ecological assessment, and SERA risk estimates. A working draft of the BERA was also presented in the draft report.

The regulatory agency comments on the draft SERA were incorporated and are presented in this Draft ESI document. The responses to regulatory comments are presented in Appendix L10.

8.1.4 Relevant Soil Data Set for SERA

Surface soil samples (0 to 1 foot bgs) that were collected as part of the RSE investigation field activities and trench samples collected between 1 and 6 feet were used to represent exposure zone for SERA purposes. Details of the surface soil sample collection and analysis are presented in Appendix G of this report.

Twenty percent of the analytical data were selected for U.S. Navy IRP Level IV data validation; 80 percent of the analytical data were selected for U.S. Navy IRP Level C data validation (DoN 1998). None of the data were assigned an "R" qualifier (data rejected); therefore, all data were useable for the risk evaluation.

8.2 SERA Process – Tier 1, Step 1 – Screening-Level Problem Formulation

Tier 1, Step 1 of SERA is divided into several sections that help define the problem at the screening level. An abbreviated site ecological description is given in Section 8.2.1. Chemicals of potential ecological concern (COPECs), as well as assessment endpoints, measurement endpoints, representative species, exposure pathway analysis, the development of a CSM, and toxicity evaluation, are identified in Sections 8.2.2 through 8.2.7, respectively.

8.2.1 Ecological Setting

Historically, AA 3 was used as a source of borrow material. Records indicate that some of the borrow pits and trenches were backfilled with construction debris and later covered with 2 to 5 feet of fill soil. Exploratory trenching results of the RSE investigation indicates that the site is covered with a minimum of 3 feet of fill soil.

Based on a review of historical aerial photographs and topographic maps, placement of construction debris occurred between 1972 and 1988. Interviews with former Station personnel indicate that construction debris generated during the construction of the IDW management area at IRP Site 3 were placed at AA 3.

Figure 8-1: EPA Superfund Eight-Step Ecological Risk Assessment Process

Note: SMDP = scientific management decision point

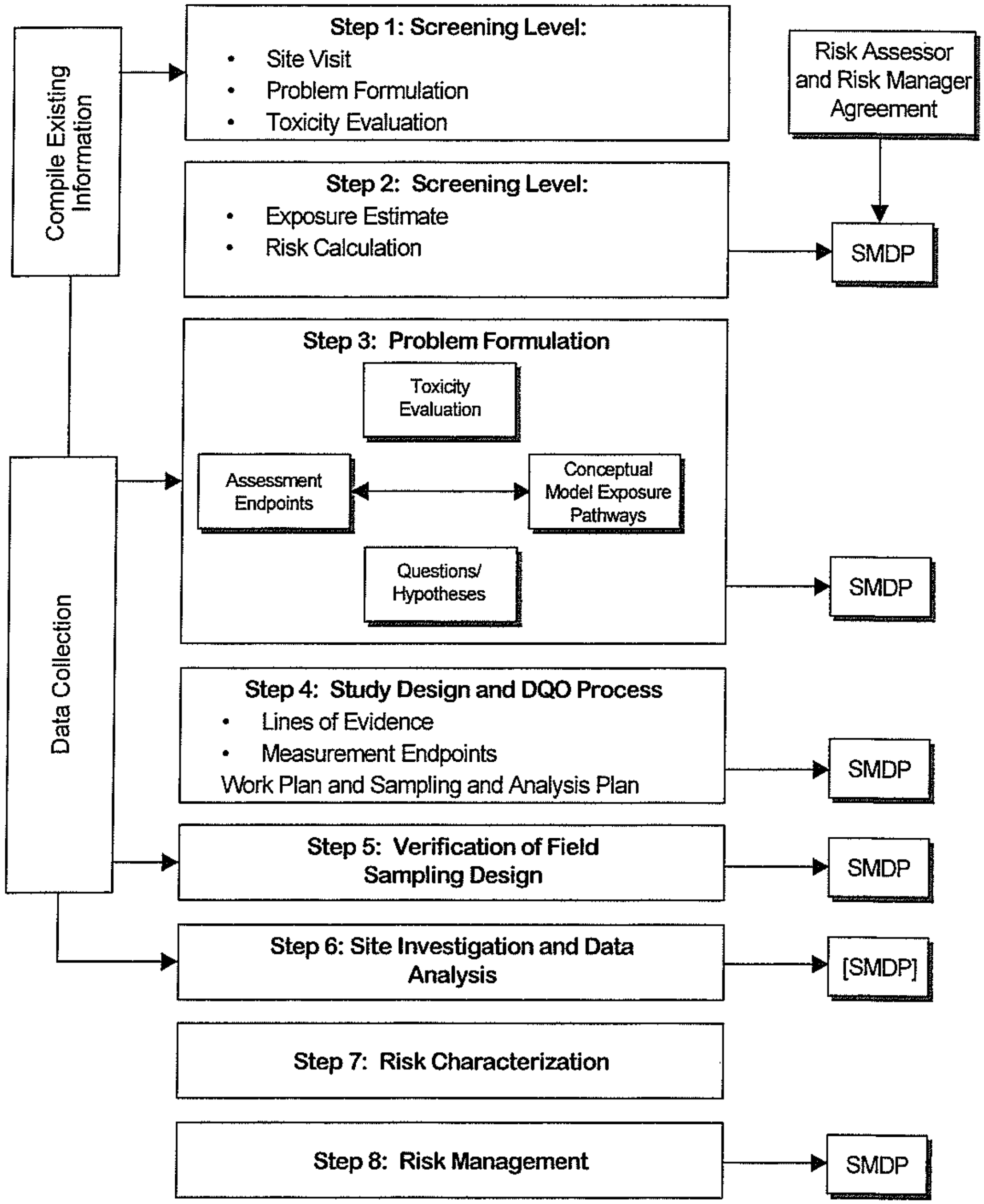

Figure 8-2: Three Tiered Navy Approach to Ecological Risk Assessment

RPM Input and Risk Management Consideration[3]

Step 8: Risk Management

Tier 1. Screening Ecological Risk Assessment (SERA): Identify pathways and compare exposure point concentrations to bench marks.

Step 1: Site visit; Pathway Identification/Problem Formulation; Toxicity Evaluation

Step 2: Exposure Estimate; Risk Calculation (SMDP)[1]

Proceed to Exit Criteria for SRA

Exit Criteria for the SERA: Decision for exiting or continuing the ecological risk assessment.

1) Site passes screening risk assessment: A determination is made that the site poses acceptable risk and shall be closed out for ecological concerns.

2) Site fails screening risk assessment: The site must have both complete pathway and unacceptable risk. As a result the site will either have an interim cleanup or moves to the second tier.

Tier 2. Baseline Ecological Risk Assessment (BERA): Detailed assessment of exposure and hazard to "assessment endpoints" (ecological qualities to be protected). Develop site specific values that are protective of the environment.

Step 3a: Refinement of Conservative Exposure Assumptions[2] (SRA)----**Proceed to Exit Criteria for Step 3a**

Step 3b: Problem Formulation - Toxicity Evaluation; Assessment Endpoints; Conceptual Model; Risk Hypothesis (SMDP)

Step 4: Study Design/DQO - Lines of Evidence; Measurement Endpoints; Work Plan and Sampling & Analysis Plan (SMDP)

Step 5: Verification of Field Sampling Design (SMDP)

Step 6: Site Investigation and Data Analysis [SMDP]

Step 7: Risk Characterization

Proceed to Exit Criteria for BERA

Exit Criteria Step 3a Refinement

1) If re-evaluation of the conservative exposure assumptions (SRA) support an acceptable risk determination then the site exits the ecological risk assessment process.

2) If re-evaluation of the conservative exposure assumptions (SRA) do not support an acceptable risk determination then the site continues in the Baseline Ecological Risk Assessment process. **Proceed to Step 3b.**

Exit Criteria Baseline Risk Assessment

1) If the site poses acceptable risk then no further evaluation and no remediation from an ecological perspective is warranted.

2) If the site poses unacceptable ecological risk and additional evaluation in the form of remedy development and evaluation is appropriate, proceed to third tier.

Tier 3. Evaluation of Remedial Alternative (RAGs C)

a. Develop site specific risk based cleanup values.

b. Qualitatively evaluate risk posed to the environment by implementation of each alternative (short term) impacts and estimate risk reduction provided by each (long-term) impacts; provide quantitative evaluation where appropriate. Weigh alternative using the remaining CERCLA 9 Evaluation Criteria. Plan for monitoring and site closeout.

1) See EPA's 8 Steps ERA Process for requirements for each Scientific Management Decision Point (SMDP).
2) Refinement includes but is not limited to background, bioavailability, detection frequency.
3) Risk Management is incorporated throughout the tiered approach.

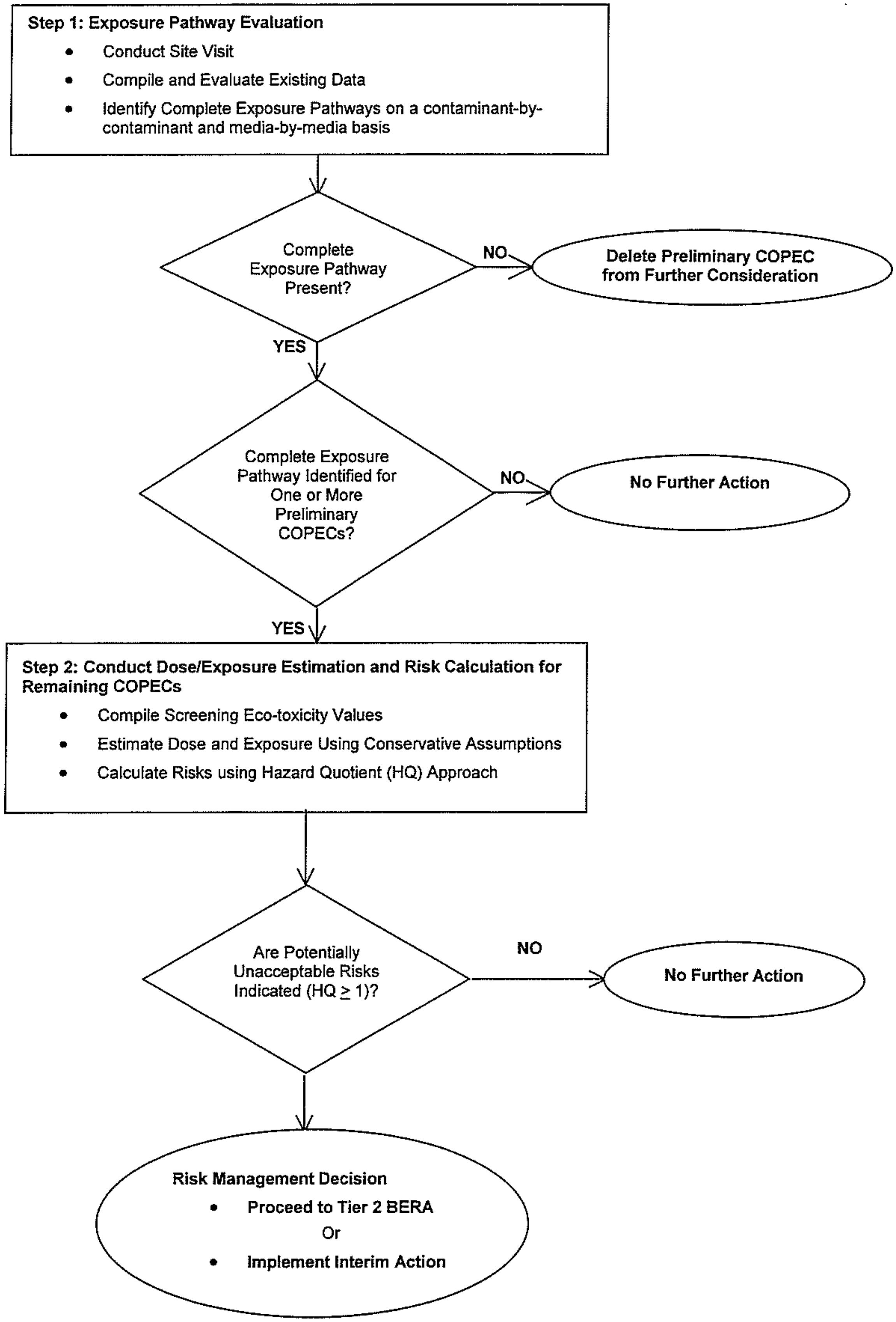

Figure 8-3: The Tier 1 Screening Risk Assessment Process

A two-phase BSR was conducted at AA 3 (an area of approximately 9 acres, including area of debris placement (5.15 acres) and surrounding habitat) during October 2002 and June 2003 to provide biological input to the screening-level problem formulation for an ERA in accordance with the legal requirements set forth under Section 7 of the Endangered Species Act of 1973, (19 United States Code [U.S.C.] 1536(c), 50 CFR 402). A complete report of BSR is presented in Section 5.5 of this report and relevant excerpts in the context of using this information for the ERA purposes are presented below.

The spring/summer habitat BSR was performed at AA 3 to identify plant and wildlife species that were not identified during the mid-winter survey. Species not observed, but having potential to be onsite, are listed in Table 5-8 (plants) and Table 5-9 (wildlife). These tables list special status species known from comparable habitats within the region and summarize their natural history, agency status, and occurrence probability on site.

Eighty-five plant species were observed, with 40 of these (47 percent) being exotic or non-native species (Table 5-6). Most of the plant species observed were typical for the southern California habitats and disturbed areas. No listed or otherwise sensitive plant species were documented on the site. Three listed plant species, which have the potential for being onsite, were not found and/or the site did not have appropriate habitat. One listed species is presumed to be extinct locally. Twenty other plant species, of lesser sensitivity have the potential to be found onsite of which, 7 were determined to be absent based on the survey and 13 have a low probability of being present, primarily because of the disturbed nature of the site.

A total of 2 reptiles, 1 amphibian, 37 avian, and 6 mammalian species were documented on the site. A complete listing of those species documented is attached (Table 5-7). Figure 5-13 presents the results of the assessment.

Most of the site (5.15 acres within AA 3) is "ruderal" vegetation (OCHCS 4.6) (Figure 5-13). There is an intermittent stream channel parallel to, and inside, the northeastern site border and outside the southeastern boundary, the latter of which supports Mulefat Scrub (OCHCS 7.3) with scattered large black willows. These willow trees are in a few patches and do not cover enough of the area to match OCHCS descriptions of Southern Willow Scrub or Southern Black Willow forest. Open patches of Mulefat scrub extend onto the project site itself in a few areas along the southeastern boundary. The area of Mulefat Scrub within AA 3 is 0.08 acre. For purposes of the ecological risk assessment for wildlife exposed to sediment, the intermittent stream channel located outside and parallel to the southeastern boundary, measuring 800 linear feet from the outfall point (upgradient) to the bridge (down gradient), was included. This occupies an area of 72,000 square feet (0.67 ha) and includes four sediment samples taken which represent sediment exposure at AA3.

A form of CSS occurs on a hillside off site to the northwest, and degraded CSS, mixed with non-native grassland, occurs on a fill slope to the east, crossing the northeastern corner of the site and extending off site to the south and southeast. The CSS offsite to the north matches OCHCS description of Southern Cactus Scrub (OCHCS 2.4). Degraded CSS matches the mixed sage scrub grassland (OCHCS 2.8.5).

8.2.1.1 WETLANDS AND WATERS OF THE U.S.

Hydrology. The field survey covered all low areas, swales, and drainage ways where water could pond or flow. One of these areas, the small head cut drainage area on the southeastern boundary of the site, shows evidence of an OHWM and is considered waters of the U.S. under Section 404 of the Federal Clean Water Act and a streambeds under Section 1603 of the California Fish and Game Code. The OHWM in this drainage way is about 5 feet wide and extends over a length of about

70 feet. Other areas, including low-lying areas and a swale parallel to the northeastern site boundary, show no OHWMs.

Soils. Soil on the anomaly area is fill material, and in the drainage way showing OHWMs, soil is composed of fine sand. Sandy soils generally do not show hydric indicators even where they are native on a site. Because of the sandy soil texture and because the soil is not native to the site, we did not attempt to find indicators of hydric soils.

Vegetation. Plants growing in the low-lying areas on the AA 3 surface are generally weedy native and non-native upland species, including red brome grass (*Bromus madritensis ssp. rubens*), tocalote (*Centaurea melitensis*), sweetclover (*Melilotus sp.*), and Spanish clover (*Lotus purshianus*). None of these species is ranked as FAC, FACW, or OBL; therefore, these depressions do not meet the criterion for hydrophytic vegetation. Garland daisy (*Chrysanthemum coronarium*) is overwhelmingly dominant along the swale near the northeastern boundary; this species also is not ranked as FAC, FACW, or OBL; therefore, the swale does not meet the criterion for hydrophytic vegetation.

8.2.1.2 Sensitive Resources

Flora. Based on the field survey and on the habitats of listed threatened and endangered plants known from the region, it can be concluded that no listed plant species occur on the project site itself (see Table 5-8).

Habitat. CSS is considered a sensitive habitat by several resource agencies. Most of this habitat is located off site. Only a small amount of the CSS, in the form of Mixed Sage Scrub Grassland (0.18 acre), is within the limits of AA 3 and none appears to be within the estimated extent of debris placement (Figure 5-13).

Wetland resources are also considered sensitive because of their scarcity in semi-arid southern California, their value to wildlife, and recent loss of this habitat from urbanization, agriculture, and flood control projects. The Mulefat Scrub and disturbed wetland are considered sensitive wetland habitats. Mulefat Scrub is only considered sensitive where it occurs in a wetland landscape position (i.e., along drainages and not on level pads). There is a very limited area of this habitat onsite, which limits its significance.

Wetlands and Waters of the U.S. One part of the site, the head cut drainage way at the southeastern boundary, potentially meets federal criteria as waters of the US and California criteria as a jurisdictional streambed (Figure 5-13). The OHWM, indicated by sediment deposits and small banks cut by running water, are about 5 feet apart over a distance of about 70 feet, so that a total of 350 square feet (less than 0.01 acre) of potentially federally jurisdictional waters of the US. This site, and no other part of the anomaly area, meets criteria as waters of the U.S.

No portion of Anomaly Area 3 meets all three federal criteria as a wetland. The head cut drainage way meets the hydrology, but not the vegetation criterion. The soils criterion could not be evaluated due to the origin and texture of soils on the site.

Wildlife. No listed or sensitive species were observed on the study site. One listed and one sensitive bird species and a sensitive mammal were documented adjacent to the site. These are discussed under the following species accounts and locations are depicted in Figure 5-13. A female Cooper's hawk was noted flying over an adjacent area but was not nesting on, or near, the study site. The likelihood of other listed or sensitive species being present is detailed in Table 5-13.

8.2.2 Identification of Chemicals of Potential Ecological Concern

Chemicals of potential ecological concern for the SERA are selected from chemicals detected in surface soil (0 to 6 feet), sediment and surface water. The analytical suite was limited to assess potential surface soil estimated risk from past activities that took place onsite. The chemical groups of analytes for the SERA include metals, TPH, VOCs, SVOCs, and dioxins. Data were validated in accordance with U.S. Navy IRP guidance for data evaluation (DoN 1998). None of the data were assigned an "R" qualifier (data rejected); therefore, all analytical data of soil samples were used for the PRE.

8.2.2.1 Surface Soil

Soil data used in the SERA include soil samples from the exposure zone (0 to 6 feet bgs). Petroleum hydrocarbons were detected in soil from 0 to 6 feet bgs; however, toxicity values do not exist to assess their potential for risk to the ecological receptors. Instead, these petroleum hydrocarbons were assessed using their toxic constituents (PAH and benzene, toluene, ethylbenzene, and total xylenes [BTEX]) that have toxicity references.

Some inorganic chemicals are needed in relatively high concentrations for normal metabolism, growth, and reproduction. Most organisms regulate the levels of these physiological electrolytes in tissues. Metals that were eliminated as potential COPECs in soil, sediment, and surface water because they are essential nutrients include sodium, potassium, calcium, magnesium, and iron.

Chemicals detected in soil (i.e., 0 to 6 feet bgs), sediment, and surface water at sampling locations were considered preliminary COPECs, provided that the analytical results were determined to be usable in the data validation process. Analytes not detected in site media were eliminated as COPECs. However, an initial screen compared the maximum reporting limits in soil and sediment to Oak Ridge National Laboratory (ORNL) values for lower trophic level species in soil (i.e., 0 to 6 feet bgs) and sediment to assess if there were any COPECs with reporting limits above screening concentrations. Surface water maximum reporting limits were compared to National Recommended Water Quality Criteria values (NRWQC) (EPA 2002c) for the protection of aquatic life for this screening.

For twelve chemicals detected in surface soil, including mercury, molybdenum, selenium, thallium, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, 2,4-dinitrophenol, 4-nitrophenol, hexachlorocyclopentadiene, and pentachlorophenol, had at least one maximum reporting limit that was higher than the respective ecological screening values (Appendix L1-1). Molybdenum, thallium, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, 2,4-dinitrophenol, 4-nitrophenol, hexachlorocyclopentadiene, and pentachlorophenol were not detected in any samples and should be given further consideration beyond this SERA because at least one of the maximum reporting limit was above the screening value. All other analytes not detected in soil samples in at least one of the samples used in the SERA did not have screening criteria available for this comparison (see Appendix L1-1).

The list of soil COPECs considered in the SERA is presented in Table 8-1. Other chemicals may have been detected at depths greater than 6 feet bgs at AA 3; however, any chemical detected at depths greater than 6 feet bgs were not included in the SERA.

8.2.2.2 Sediment

Four sediment samples were collected at the bottom of Agua Chinon Wash. The wash is ephemeral and benthic organisms are not present. Therefore, sediment data were evaluated using terrestrial receptors to evaluate potential risk.

Mercury was detected in one out of four samples and the reporting limits exceeded its screening value; therefore, mercury will be assessed in the SERA. All other analytes not detected in sediment in at least one of the four samples did not have screening criteria available for this comparison (see Appendix L1-2).

The list of sediment COPECs considered in the SERA is presented in Table 8-2.

Table 8-1: Maximum Concentrations of COPECs Detected in Exposure Zone Soil (0 – 6 feet)

COPEC	Maximum Soil Concentration
VOCs (µg/kg)	
Acetone	100
Methylene chloride	9.2
SVOCs (µg/kg)	
Anthracene	44
Benzo(a)anthracene	730
Benzo(a)pyrene	1,030
Benzo(b)fluoranthene	1,790
Benzo(g,h,i)perylene	440
Benzo(k)fluoranthene	510
Bis(2-Ethylhexl)phthalate	70
Chrysene	870
Dibenz(a,h)anthracene	97
Diethyphthalate	225
Fluoranthene	1,000
Hexachlorobenzene	150
Indeno(1,2,3-cd)pyrene	460
Phenanthrene	290
Phenol	936
Pyrene	960
Metals (mg/kg)	
Aluminum	15,800
Antimony	2.1
Arsenic	4.63
Barium	187
Beryllium	0.31
Cadmium	1
Chromium	15.8
Cobalt	7.6
Copper	10.8
Lead	20.7
Manganese	289
Mercury	0.069
Nickel	13.7

Table 8-1: Maximum Concentrations of COPECs Detected in Exposure Zone Soil (0 – 6 feet)

COPEC	Maximum Soil Concentration
Selenium	1.1
Silver	2
Vanadium	44.1
Zinc	57.1
Dioxins (pg/g)	
Total 2,3,7,8-TCDD TEQ (Bird)[1]	35.3
Total 2,3,7,8-TCDD TEQ (Mammal)[1]	18.5

Notes:
COPEC = chemical of potential ecological concern
mg/kg = milligrams per kilogram
VOC = volatile organic compound
TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
TEF = toxicity equivalency factor
µg/kg = micrograms per kilogram
pg/g = picograms per gram
SVOC = semivolatile organic compound
TEQ = Toxicity equivalent quotient
[1] TEQ value calculated based on TEFs for birds and mammals respectively.

Table 8-2: Maximum COPEC Concentrations Detected in Sediment

COPEC	Maximum Exposure Point Concentration (mg/kg)
Metals	
Aluminum	3,050
Arsenic	1.8
Barium	110
Cadmium	0.26
Chromium	4.4
Cobalt	2
Copper	2.5
Lead	1.9
Manganese	130
Mercury	0.006
Nickel	2.8
Selenium	0.17
Vanadium	13.9
Zinc	13.5

Notes:
COPEC = chemical of potential ecological concern
mg/kg = milligrams per kilogram

8.2.2.3 Surface Water

Two surface water samples were collected for the SERA. Water at the site is ephemeral, so no aquatic communities are present in the area of AA 3. Copper was not detected in either of the two surface water samples; however, it was assessed further since the reporting limit exceeded its screening value. All other analytes not detected in surface water in at least one of the two samples did not have screening criteria available for this comparison (see Appendix L1-3).

The list of surface water COPECs considered in the SERA is presented in Table 8-3.

Table 8-3: Maximum COPEC Concentrations Detected in Surface Water

COPEC	Maximum Exposure Point Concentration (ug/L)
Metals	
Aluminum	87,500
Arsenic	34.2
Barium	871
Beryllium	2.7
Cadmium	6.4
Chromium	83.5
Cobalt	31.5
Lead	28.2
Manganese	1,070
Nickel	78.5
Vanadium	227
Zinc	286

Notes:
COPEC = chemical of potential ecological concern
µg/L = micrograms per liter

8.2.3 Assessment Endpoints

Assessment endpoints are "explicit expressions of the actual environmental value that is to be protected" (EPA 1992b). Assessment endpoints are critical to problem formulation, because they link the risk assessment to management concerns and are central to developing the CSM (EPA 1997b).

According to EPA guidance (EPA 1997b), the assessment endpoint for any SERA is an adverse effect on an ecological receptor. Ecological receptors are defined as plant and animal populations, communities, habitats, or sensitive environments. More specifically, the assessment endpoints for the SERA included the protection and maintenance (survival, growth, and reproduction) of:

- local herbivorous birds
- local omnivorous birds
- local carnivorous birds
- local omnivorous mammals
- local insectivorous mammals
- local carnivorous mammals

8.2.3.1 Measures of Effects

Measurement endpoints (measures of effects) corresponding to the survival and reproductive effects were identified for the representative species or their surrogates.

Surface soil screening values for lower trophic level species included EcoSSLs (EPA 2003a) and ORNL plant toxicological benchmarks (Efroymson et al. 1997a) and soil invertebrate toxicological benchmarks (Efroymson et al. 1997b).

Adverse effects of exposure to COPECs on the survival and reproduction/development of the representative bird and mammal species or their surrogates were obtained from peer-reviewed publications. Measurement endpoints were NOAELs for ingestion of each COPEC in chronic feeding studies conducted on the same representative species or a related species. This information was used to develop an exposure below which adverse effects are not expected to occur (Toxicity Reference Value [TRV]). When no toxicity test data were available for a particular representative animal, surrogate animal data were used to generate the TRVs.

Measures of effects provide the actual measurements used to evaluate ecological risk and are selected to represent mechanisms of toxicity and exposure pathways. Measures of exposure generally include measured or modeled concentrations of chemicals in water, sediment, soil, birds, and/or mammals. Measures of effects include laboratory toxicity study results and field observations. The specific measurement endpoints identified for the SERA are all quantitative comparisons between COPEC concentrations and risk-based screening values or chronic daily intakes and NOAEL-based TRVs.

Final assessment and measurement endpoints are summarized in Table 8-4.

Table 8-4: Summary of Assessment and Measurement Endpoints

Receptor of Concern	Exposure Pathway	Assessment Endpoint *	Testable Hypothesis	Measures of Effect	Data Available
Plants	Root uptake of chemicals in soil	Decrease in plant growth and reproduction	H_0: The concentration of chemicals in surface soil does not exceed a level known to be toxic to plants.	Compare concentration of chemicals in soil to risk-based soil benchmark concentrations developed to protect plant growth and reproduction.	Site-specific chemical data for surface soil from potentially impacted locations
Soil invertebrates	Uptake of chemicals in soil	Decrease in growth and reproduction of soil invertebrates	H_0: The concentration of chemicals in surface soil does not exceed a level known to be toxic to soil invertebrates.	Compare concentration of chemicals in soil to risk-based soil benchmark concentrations developed to protect growth and reproduction of soil invertebrates.	Site-specific chemical data for surface soil from potentially impacted locations
Small omnivorous mammals (represented by deer mouse)	Ingestion of chemicals accumulated in plants, soil invertebrates and from soil	Decline in small mammal populations	H_0: The ingestion of bioaccumulative chemicals in soil, sediment, and plants, and surface soil invertebrates does not exceed a level known to be toxic to mice.	Compare modeled COPEC chronic intake concentrations in representative small mammal species to determine exceedance of no-effect-level thresholds based on TRVs.	Site-specific chemical data for surface soil from potentially impacted locations
Small insectivorous mammals (represented by ornate shrew)	Ingestion of chemicals accumulated in soil invertebrates insects, and from soil	Decline in small mammal populations	H_0: The ingestion of bioaccumulative chemicals in surface soil, sediment and soil invertebrates does not exceed a level known to be toxic to ornate shrews.	Compare modeled COPEC chronic intake concentrations in representative mammal species to determine exceedance of no-effect-level thresholds based on TRVs.	Site-specific chemical data for surface soil from potentially impacted locations
Carnivorous mammals	Ingestion of chemicals	Decline in mammal	H_0: The ingestion of bioaccumulative	Compare modeled COPEC chronic intake concentrations in	Site-specific chemical data for surface soil

Table 8-4: Summary of Assessment and Measurement Endpoints

Receptor of Concern	Exposure Pathway	Assessment Endpoint *	Testable Hypothesis	Measures of Effect	Data Available
(represented by long-tailed weasel)	accumulated in small mammals, birds, and from soil	populations	chemicals in small mammals, birds, soil and sediment does not exceed a level known to be toxic to the long-tailed weasel.	representative mammal species to determine exceedance of no-effect-level thresholds based on TRVs.	from potentially impacted locations
Small herbivorous birds (represented by mourning dove)	Ingestion of chemicals accumulated in plants and from soil	Decline in small bird populations	H_0: The ingestion of bioaccumulative chemicals in plants and surface soil does not exceed a level known to be toxic to birds.	Compare modeled COPEC chronic intake concentrations in representative bird species to determine exceedance of No-effect-level thresholds based on TRVs.	Site-specific chemical data for surface soil from potentially impacted locations
Small insectivorous birds (represented by western meadowlark)	Ingestion of chemicals accumulated in soil invertebrates, insects, and from soil	Decline in small bird populations	H_0: The ingestion of bioaccumulative chemicals in surface soil, sediment, and soil invertebrates does not exceed a level known to be toxic to western meadowlarks	Compare modeled COPEC chronic intake concentrations in representative bird species to determine exceedance of no-effect-level thresholds based on TRVs.	Site-specific chemical data for surface soil from potentially impacted locations
Small omnivorous birds (represented by spotted towhee)	Ingestion of chemicals accumulated in plants, soil invertebrates, and from sediment	Decline in local bird populations	H_0: The ingestion of bioaccumulative chemicals in sediment invertebrates and surface soil does not exceed a level known to be toxic to birds.	Compare modeled COPEC chronic intake concentrations in representative bird species to determine exceedance of no-effect-level thresholds based on TRVs.	Site-specific chemical data for surface soil from potentially impacted locations
Carnivorous birds (represented by red-shouldered hawk)	Ingestion of chemicals accumulated in small mammals, birds, and from soil	Decline in raptor populations	H_0: The ingestion of bioaccumulative chemicals in birds, small mammals, surface soil, and sediment does not exceed a level known to be toxic to birds.	Compare modeled COPEC chronic intake concentrations in representative bird species to determine exceedance of no-effect-level thresholds based on TRVs.	Site-specific chemical data for surface soil from potentially impacted locations
Aquatic life	Ingestion of chemicals accumulated in aquatic organisms	Decline in aquatic organism populations	H_0: The concentration of chemicals in surface water does not exceed a level known to be toxic to aquatic organisms.	Compare concentration of chemicals in surface water to risk-based surface water benchmark concentrations developed to protect survival, growth, and reproduction of aquatic organisms.	Site-specific chemical data for surface soil from potentially impacted locations

NOTES:
* Assessment endpoints identified for evaluation in the SERA are based on the parameters used to derive toxicity benchmarks (see Measurement Endpoint column) and are not intended to imply measurement of these parameters in the field.

H_0 = null hypothesis

8.2.4 Selection of Representative Species

Consistent with the Navy policy, the ecological receptors selected for a Tier 1 SERA

- reflect important ecosystem components at the site;
- are representative of major trophic levels at the site;
- can serve as surrogates for "important" ("important" means species valued by regulators for reasons other than that species ecological importance) species; and
- are species for which adequate exposure information is available.

Few terrestrial species have been identified from the affected area. Several species must be selected to represent exposure characteristics of the flora and fauna of the area, both present and future.

The Navy policy states that the selection of the representative species must begin with identification of trophic levels associated with different habitats. Then, based on the identification, a surrogate species that is representative of the broader trophic levels should be chosen. Since the identification of the representative receptors involves professional judgment and depends on the assessment endpoints (Section 8.2.3) identified for the site, the Navy encourages seeking regulatory concurrence on the use of the ecological receptors for the site. The selection of the representative species for the Tier 1 SERA was based on the following ecological and species-specific selection criteria:

> **Ecological Importance.** This includes those species that affect the structure and function of existing habitats, communities, or ecosystems (e.g., key members of the local food web). The representative species are major intermediate components in the food web; if a population of a pivotal species is disrupted, there could be consequences throughout the food web, resulting in an ecosystem balance disruption.
>
> **Body Size.** Species of small body size are preferred, because they are likely to be more affected by a given exposure. Due to their higher metabolic demands, small species tend to eat more food per unit body weight per day than do larger animals.
>
> **Active Area.** Species with small site use areas or home ranges are likely to be more affected by contamination at the site because a higher percentage of their foraging may occur in contaminated areas. EPA screening guidance requires the assumption that the site use factor (SUF) is 1.
>
> **Feeding Guild.** Certain methods of finding, processing, and consuming food present a higher risk of exposure than do others. For example, the ash-throated flycatcher forages by swooping from a hunting perch to catch insects of the air, whereas the western meadow lark and spotted towhee forage on the ground, where they are more likely to contact soil contaminants (Ehrlich et al. 1988).
>
> **Diet.** Species with a specialized diet are likely to be more affected by a given contaminant exposure pathway and changes in food species density because they have fewer food alternatives.
>
> **Fecundity.** Species having small litter or egg clutch sizes and fewer litters or clutches per year are likely to be more impacted by adverse effects on reproductive success.

Resident or Nesting Species. Resident or nesting species are likely to be more affected by contamination at the site because they may spend more time in the contaminated area per year.

Generally, representative species selection is based largely on the species' ecological importance and their habits that tend to lead to maximum exposure to soil pathways. It is assumed that the evaluation of risk to these maximally exposed species will represent risk to other species that are less exposed to soil pathways (i.e., leaf gleaning birds), thus protecting all species. Using the selection criteria discussed above, the animals listed in Table 5-7 were examined to identify appropriate representative terrestrial species. In consideration of all of the exposure-related factors, species identified in Table 5-7, and discussions with the regulators, seven species were selected as representative terrestrial species (Table 8-5). These species included some that may not be documented at the site; however, they are known to exist in the area. The seven species (4 birds and 3 mammals) represent ground-feeding herbivores, insectivores, and predators.

Table 8-5: Selected Representative Terrestrial Species for the SERA

Common Name	Scientific Name	Justification (Critical Ecosystem Role)
Ornate shrew	*Sorex ornatus*	Insectivore
Deer mouse	*Peromyscus maniculatus*	Omnivore (classified as herbivore for SERA)
Long-tailed weasel	*Mustela frenata*	Carnivore
Western meadowlark	*Sturnella neglecta*	Omnivore (classified as insectivore for SERA)
Spotted towhee	*Pipilo maculates*	Omnivore
Mourning dove	*Zenaida macroura*	Herbivore
Red-shouldered hawk	*Buteo lineatus*	Carnivore

The selected representative species at the site include the following:

The **ornate shrew** (*Sorex ornatus*) is a small (5.85 grams), insectivorous mammal (Brown et al. 1996). Because of its small size and high metabolism, it consumes a large amount of food for its size (1.91 grams/day), thus maximizing its exposure to site chemicals. Several subspecies of the ornate shrew are considered threatened or endangered in parts of its range, although no threatened or endangered populations are found in the area of the site. Ornate shrews prefer mesophytic communities with dense cover and an abundant litter layer. They build dome-shaped nests made of dead plant material and paper scraps, usually on top of the soil surface below driftwood or planks situated above the high tide line (WESCO 1986). The ornate shrew is assumed to forage in all habitats at the site. An ecological profile of this species is presented in Appendix L2. For the SERA, the ornate shrew is assumed to be completely insectivorous.

The **deer mouse** (*Peromyscus maniculatus)* ranges in length from 7.1 to 10.2 centimeter (cm) (Burt and Grossenheider 1976) with weights ranging from 18.3 to 20.9 grams (Schlessinger and Potter 1974). The deer mouse nests in burrows in the ground, in trees, stumps, and buildings. They inhabit nearly all types of dry-land habitats within their range: short grass prairies, grass-sage communities, CSS, sand dunes, wet prairies, upland mixed and cedar forests, deciduous forests, and ponderosa pine forests (Holbrook 1979; Kaufman and Kaufman 1989; Ribble and Samson 1987; Wolff and Hurlbutt 1982).

Deer mice eat seeds, arthropods, some green vegetation, roots, fruits, and fungi as available (Johnson 1961; Menhusen 1963; Whitaker 1966). An ecological profile of this species is presented in

Appendix L2. The deer mouse is assumed to forage in all habitats at the site. For the SERA, the deer mouse is assumed to be completely herbivorous.

The **long-tailed weasel** (*Mustela frenata*) cited range of adult weights is 80 to 450 grams (Baker 1983). For the purposes of the SERA, a mean weight of 265 grams is used. Weasels are found in temperate and tropical habitats in North and Central America. They inhabit crop fields and small wooded areas and will burrow and nest in hollow logs, rock piles, and under barns. Weasels sometimes take over the burrow of one of their prey (Baker 1983).

Weasels are strictly carnivorous but may ingest some soil while feeding. They prey on mammals up to rabbit size, and also take a few birds and other animals by piercing the prey's skull with its canines and killing it (Burt and Grossenheider 1976). An ecological profile of this species is presented in Appendix L2. For the SERA, the long-tailed weasel is assumed to be completely predatory and forage in all habitats at the site.

The **mourning dove** (*Zenaida macroura*) has a weight that ranges from 115 to 140 grams, with a mean weight of 119 grams (Dunning 1993). Mourning doves can be found in the desert (near water) to open woodland, agricultural areas with scattered trees, and suburbs. They will nest in the fork of a horizontal tree branch, on the ground, on the deserted nest of other species, or anywhere else providing solid support (Ehrlich et al. 1988). Since the mourning dove's diet consists of seeds, including waste grain from cultivated fields (Ehrlich et al. 1988), incidental ingestion of soil will occur. An ecological profile of this species is presented in Appendix L2. For the SERA, the mourning dove is assumed to be completely herbivorous and forage in all habitats at the site.

The **western meadowlark** (*Sturnella neglecta)* is a medium-sized (94 grams) bird that measures about 11 inches long and has a five-inch tail (Dunn 1998). The western meadowlark's feeding habits are marked by seasonal differences in their main staples. They eat grain during winter and early spring, insects late spring and summer, and weed seeds in fall (Lanyon 1994). The feeding habits allow for an assumption of maximal exposure to COPECs. An ecological profile of this species is presented in Appendix L2. For the SERA, the western meadowlark is assumed to be completely insectivorous and represents birds that feed in the open areas of the site.

The **spotted towhee** body weight ranges from 32.1to 52.3 grams and ranges in length from 18 to 20 cm (Clench and Leberman 1978). In California, the spotted towhee can be found in chaparrals and other shrub habitats and in open stands of riparian, hardwood, hardwood-conifer, and lower-elevation conifer habitats (Dobkin 2003). During the spring and summer, the spotted towhee's diet consists of approximately 50 percent insects, with the remainder including seeds, other invertebrates, berries, and acorns (Martin et al. 1961). It forages by scratching and gleaning in litter and foliage, sometimes by plucking seeds and fruits from plants, and on rare occasions fly-catching (Davis 1957). An ecological profile of this species is presented in Appendix L2. For the SERA, the spotted towhee is assumed to be completely omnivorous and represents birds that feed in the thickets of riparian habitat.

The **red-shouldered hawk** has a mean body weight of 559 grams and maximum weight of 720 grams (Hartman 1961). Adults are 41 cm in length and have a 102 cm wingspan (Robbins et al. 1966). The typical habitat for the Red-shouldered hawk includes dense riparian deciduous cover, bordered by foraging areas (edges, swamps, marshes, and wet meadows). In the western Sierra Nevada foothills, it can be found foraging in successional stages of valley foothill hardwood and valley foothill hardwood-conifer habitats (Polite 2003). The red-shouldered hawk searches for prey from its perches on trees, snags, and posts. It primarily feeds on small mammals, snakes, lizards, amphibians, small or young birds, and large insects (Polite 2003). An ecological profile of this species is presented in Appendix L2. For the SERA, the red-shouldered hawk is assumed to be completely predatory and forage in all habitats at the site.

A summary of the SERA exposure characteristics that were used for the representative species is presented in Table 8-6.

The **earthworm** (*Eisenia fetida*) was chosen to represent terrestrial invertebrates for purposes of food chain modeling because of its small size and range, its position as a decomposer in the food web, and its soil contact and diet. It is also a prey species for many small carnivorous animals, such as the deer mouse. In addition, the earthworm serves as a conservative surrogate for other terrestrial invertebrate food species, such as insects. It is assumed that the earthworm is maximally exposed to soil contaminants because of its burrowing habit and ingestion of soil. Other invertebrates would be less exposed to site soil contaminants than the earthworm. Earthworm bioconcentration factor values are used to model food chain exposure concentrations.

8.2.5 Exposure Pathway Analysis

Soil (0 to 6 foot bgs), surface water, and sediment have been chosen as the media of concern for AA 3. Exposure pathways differ in importance from species to species and from site to site. For example, sites with minimum habitat value may be used by species that tolerate human disturbance of natural habitats. The representative species that were selected for assessment endpoints are the ornate shrew, deer mouse, long-tailed weasel, western meadowlark, spotted towhee, mourning dove, and red-shouldered hawk.

The major terrestrial pathways chosen for analysis in this ERA are as follows:

- Uptake of chemicals in surface soil by plants (via roots) and soil invertebrates
- Ingestion of contaminated surface soil by animals (mammals and birds)
- Ingestion of contaminated plants by animals (deer mouse and mourning dove)
- Ingestion of contaminated soil invertebrates by animals (ornate shrew, spotted towhee, and western meadowlark)
- Ingestion of contaminated prey by predators (long-tailed weasel and red-shouldered hawk)
- Uptake of contaminants in water by aquatic organisms
- Uptake of contaminants in sediment by benthic organisms

8.2.5.1 Species-Specific Exposure Factors

Factors used to estimate COPEC intake values for ecological animal receptors are referred to as exposure factors. Defining exposure factors is essential to estimating COPEC intake values. Factors such as species morphology, physiology, and behavior influence how individuals are exposed to COPECs and how much of a given COPEC in a given medium is taken in by an individual representative species. Characteristics of representative species that are used to estimate exposure are presented in Appendix L2 and summarized in Table 8-6. Uncertainties associated in applying these exposure factors in equations to calculate intake values are a complex issue; uncertainties are discussed in Section 8.3.3.

Table 8-6: Summary of SERA Species-Specific Exposure Factors

Factor	Value	Reference
Ornate shrew		
Minimum body weight (kg)	0.0041	Brown et al. (1996)
Maximum food intake (mg/d, dry wt)	1,317	Deavers and Hudson (1981); Nagy (2001)
Water intake (mL/day)	1.0 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.0 (plant) 0.98	Derived from DOI (2002)
Deer mouse		
Minimum body weight (kg)	0.0183	Derived from Schlesinger and Potter (1974)
Maximum food intake (mg/d, dry wt)	3,491 [a]	Nagy (2001)
Water intake (mL/day)	2.9 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.98 (plant) 0.00 (animal)	SERA Assumption [c]
Long-tailed weasel		
Minimum body weight (kg)	0.080	Baker (1983)
Maximum food intake (mg/d, dry wt)	24,973 [a]	Nagy (2001)
Water intake (mL/day)	30 [b]	EPA (1993)
Diet Partition Factor	0.03 (soil)	Beyer et al (1994), similar to fox
	0.00 (plants) 0.97	Derived from Burt and Grossenheider (1976)
Western Meadowlark		
Minimum body weight (kg)	0.0741	Lanyon (1962)
Maximum food intake (mg/d, dry wt)	16,003 [a]	Nagy (2001)
Water intake (mL/day)	12 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.00 (plants) 0.98	SERA Assumption [c]
Spotted towhee		
Minimum body weight (kg)	0.0321	Clench and Leberman (1978)
Maximum body weight (kg)	0.0523	
Maximum food intake (mg/d, dry wt)	9,399 [a]	Nagy (2001)
Water intake (mL/day)	6.9 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.00 (plants) 0.98	SERA Assumption [c]
Mourning Dove		
Minimum body weight (kg)	0.115	Dunning (1993)
Maximum body weight (kg)	0.140	
Maximum food intake (mg/d, dry wt)	18,414 [a]	Nagy (2001)
Water intake (mL/day)	14.2 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.98 (plants) 0.00 (animal)	Derived from Erlich et al., (1988)
Red-Shouldered Hawk		
Minimum body weight (kg)	0.398	Hartman (1961)

Table 8-6: Summary of SERA Species-Specific Exposure Factors

Factor	Value	Reference
Maximum body weight (kg)	0.720	
Maximum food intake (mg/d, dry wt)	66,576 [a]	Nagy (2001)
Water intake (mL/day)	40 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.00 (plants) 0.98	Derived from Polite (2003)

Notes:

kg	kilogram	ha	hectare
mg	milligram	mL	milliliter

a Dry weight food intake estimated based on algorithm given in Nagy (2001).
b Water intake estimated based on algorithm given in EPA (1993).
[c] Conservative Tier I assumption of maximum food intake of the one food item with the highest contamination.

The most conservative species-specific exposure factors are used to estimate Tier 1 exposure:

- Assume weight is low end of range and food intake is the high end of the range
- Assume 100 percent bioavailability of COPECs
- Assume the most sensitive life stage is present on the site
- Assume species is present year-round
- Use maximum concentration of contaminant in exposure media
- Assume SUF is 1

Body Weight (BW). The lowest of the adult male and female body weights is used to estimate exposure because it is the most conservative assumption.

Food Intake (FI)/Day. The daily diet, in milligram of organic matter eaten per day, determined on a dry-weight basis, for an individual of maximum size.

SUF. The site use factor is defined as

$$SUF = \frac{Area\ of\ Surface\ Soil\ Contamination}{Site\ Use\ Area\ of\ Animal}$$

This factor permits consideration of less than full-time exposure for animals with site use areas exceeding the area of contamination. When the site use area of the receptor is less than the size of the site, it is assumed that the animal occupies the site 100 percent of the time, and the SUF is equal to 1. It is assumed that these receptors are continuously exposed to site contaminants.

Diet Partitioning Factor. The diet of animal receptors may be defined by three major exposure pathways:

- Direct ingestion of soil—soil ingestion (SI)
- Ingestion of contaminated plant materials—plant ingestion (PI)
- Ingestion of contaminated animal prey—animal ingestion (AI)

For Tier 1 screening assessment, the conservative assumption is that the diet consists entirely of the most contaminated diet fraction. This is assumed to be soil invertebrates for the ornate shrew, western meadowlark, and spotted tohee; seeds and vegetation for the deer mouse and mourning dove, and contaminated mammals for the long-tailed weasel and red-shouldered hawk.

8.2.5.2 CHEMICAL-SPECIFIC EXPOSURE FACTORS

Exposure of representative species also depends, to some extent, on chemical-specific factors, such as solubility or tendency to bioaccumulate (Appendix L3).

Soil-to-Plant Bioconcentration Factor (BCF_p). BCF_p values are used to convert chemical concentrations in soil to concentrations in plant biomass resulting from plant root uptake. This factor is used to estimate the concentration of a COPEC that bioaccumulates in plants grown in contaminated soil over one growing season. This factor is also used to model concentrations of COPECs through plants to herbivores. Use of this factor assumes that plant root uptake for a specific chemical is equal for all plants.

BCF_p values are obtained from the literature or derived from a chemical-specific octanol/water partition coefficient (K_{ow}) by the method of Travis and Arms (1988) as refined by EPA (2003). Some degree of uncertainty is associated with the use of this factor, especially for perennial plants. For the most part, however, animals feed on portions of the plants that are renewed annually (i.e., foliage, seeds, and fruit).

Soil-to-Invertebrate Bioconcentration Factor (BCF_i). BCF_i values are derived from studies of earthworm uptake and are used to convert chemical concentrations in soil to concentrations in invertebrate biomass resulting from both ingestion and integument sorption. This factor is used to estimate the concentration of a COPEC that bioaccumulates in invertebrates living in contaminated soil.

The primary terrestrial exposure pathways potentially present at the site for both plant and animal receptors are contaminated soil pathways, including uptake from soil by plants and invertebrates and ingestion of soil and contaminated food by higher trophic level organisms, such as birds and mammals.

Prey-to-Predator Bioconcentration Factor (BTF_a). BTF_a values were used to estimate chemical concentrations in predators that eat prey living on potentially contaminated areas of the site. The factor was used to model concentrations of COPEC's through prey to their predators. The BTF_a values are obtained from the literature or derived from chemical-specific K_{ow}s by the method of Travis and Arms (1998) as refined by Birak et al. (2001).

8.2.6 Development of Conceptual Site Model

8.2.6.1 SURFACE SOIL

Three potential pathways exist for ecological receptors to come into contact with surface soil chemicals. Terrestrial wildlife are expected to incidentally ingest surface soil as part of normal feeding activities; therefore, this pathway is considered complete and is evaluated quantitatively. Terrestrial wildlife ingest plant parts (i.e., leaves, seeds, roots) and soil invertebrates that may have taken up COPECs from the soil into their body tissues; therefore, ingestion of contaminated food is considered a complete exposure pathway and is evaluated quantitatively. Mammal and bird predators may eat contaminated prey. Burrowing mammals may contact subsurface soils, although the majority of exposure to COPECs is through ingestion of food.

Inhalation of contaminated dust is expected to be insignificant because the site is well vegetated and dust generation is minimal. Ecological receptors are not expected to come into contact with subsurface soils (soils below 6 feet); therefore, this exposure pathway is considered incomplete.

8.2.6.2 SEDIMENT

Two potential pathways exist for ecological receptors to come into contact with sediment in Agua Chinon Wash. Benthic organisms may live within or on bottom sediments of Agua Chinon Wash so that it is not possible to separate exposure by ingestion of food or sediment and dermal/gill contact. These exposure pathways are lumped together into total "uptake" for risk evaluation. Benthic organisms are limited due to the brief time surface water is available, and this pathway is not assessed. Terrestrial riparian species may be exposed to COPECs in dry sediments in the wash throughout most of the year, and wash sediments were assessed as a separate terrestrial soil pathway. Although the samples were collected from the wash bottom, the exposure was assumed to occur throughout the mulefat scrub habitat that occupies the banks adjacent to the stream (approximately 0.67 ha).

8.2.6.3 SURFACE WATER

Three potential pathways exist for ecological receptors to come into contact with surface water in Agua Chinon Wash. Aquatic organisms may live in the ephemeral surface water of Agua Chinon Wash, so that it is not possible to separate exposure by ingestion of water and dermal/gill contact. These exposure pathways are lumped together into total "uptake" for risk evaluation. Although water does not normally persist in the wash long enough to support an aquatic community, it is screened against chronic water quality criteria. Water is not available for terrestrial species to drink for a long enough period to be a significant exposure concern.

Groundwater is considered beyond the reach of ecological receptors unless it discharges to the surface. Because it does not reach the surface on the site or in the immediate area, the groundwater pathway is considered incomplete for ecological receptors.

The relationships between analytes in the site media and potential exposure pathways to ecological receptors are summarized in the CSM presented in Figures 8-4 and 8-5.

8.2.7 Toxicity Evaluation

The toxicity evaluation consists of identification of screening benchmark concentrations for surface soil. Maximum detected analytes in site surface soil were screened initially against EcoSSLs (EPA 2003a) and ORNL soil screening values based on the protection of plants (Efroymson et al. 1997a) and soil invertebrates (Efroymson et al. 1997b). These are based on toxicity studies of plants and soil invertebrates and are used to predict adverse effects on lower trophic level ecological receptors. HQs were also calculated for each COPEC to compare estimates of chronic daily intake (for mammals and birds) to TRVs (see Section 8.3.2.1 for further details).

NOAEL-based TRVs based on laboratory feeding studies of birds and mammals were used to calculate HQs for soil COPECs. A TRV is a dosage (for animals, in milligram of contaminant per kilogram of body weight per day [mg/kg-day]) of a chemical believed to have no effect on the long-term health of the representative species. TRVs are specific for each chemical, receptor, and exposure route (e.g., ingestion, inhalation). The TRV of a chemical is equivalent to the exposure-specific, literature-derived NOAEL of that chemical for a particular plant or animal species of concern as published in the peer-reviewed toxicology literature.

The potential for adverse effects to be caused by exposure to site chemicals was evaluated based on toxicity experiments conducted, for the most part, in the laboratory and reported in scientific literature. Acceptable TRVs were developed from NOAELs for ingestion of each COPEC in chronic feeding studies conducted on the same representative species or a related species. The primary source of TRVs was the "TRV-low level," which was developed by the Navy as part of a regional approach for conducting ERAs (Engineering Field Activity West [EFAW] 1998), in cooperation with the EPA Region IX Biological Technical Assistance Group. The TRVs used by EPA (2003) to develop EcoSSLs were used in this risk assessment for the few chemicals for which they are available. For chemicals lacking EcoSSLs or not listed in the Navy document, NOAELs were taken from peer-reviewed toxicology literature. Because the toxicity information sought was not always available in the literature, extrapolations were sometimes required. The three general categories of extrapolations were (1) taxonomic extrapolations, (2) endpoint extrapolations, and (3) chemical extrapolations. Use of these extrapolations sometimes required the application of uncertainty factors in generating TRVs, as described below.

8.2.7.1 Taxonomic Extrapolation

Taxonomic extrapolation assumes that toxicological effects reported for one species can be used to predict the toxicological effects in a taxonomically related species. These assumptions have proven valid in extrapolations used to estimate toxicity in aquatic species (EPA 1989b). Although little is known about extrapolations to assess risk to terrestrial plant and animal species, the paucity of specific toxicity data mandates such extrapolations. As an example of the use of taxonomic extrapolation, an uncertainty factor of 10 is assigned to toxicity data derived from laboratory rats if the species of concern is a bird. This assumes that birds are always more sensitive to organic chemicals than mammals. This is considered conservative because among chemicals with measured toxicity in both birds and mammals, birds are sometimes more sensitive and sometimes less sensitive than mammals.

8.2.7.2 Endpoint Extrapolation

If NOAEL endpoint values were not available, LOAEL values were multiplied by 0.1 to estimate a surrogate NOAEL, as specified by EPA (1997b). If chronic studies were not available, subchronic study results were multiplied by 0.5 to estimate chronic results. Additional adjustments of TRVs to account for other sources of uncertainty are not recommended in the EPA (1997b) guidance.

8.2.7.3 Chemical Extrapolation

Chemical extrapolation assumes that a chemical of similar physical and chemical properties to a COPEC may serve as a surrogate for that COPEC. For mammals, laboratory toxicity tests for naphthalene and B[a]P were used to represent toxicity of the less toxic and more toxic PAHs respectively. For birds, only toxicity data for phenanthrene is available. This LOAEL was used to develop a bird toxicity value for the low-toxicity PAHs by dividing the LOAEL by 10 to estimate a NOAEL. This NOAEL was divided by 10 again to estimate the TRV for high-toxicity PAHs such as B[a]P. Thus, it is assumed that B[a]P is at least 10 times more toxic than phenanthrene.

8.2.7.4 Allometric Conversions of TRVs

General TRVs for birds and mammals must be converted to TRVs specific to each regional, site-specific receptor of concern (EFAW, 1998). This extrapolation of data based on body scaling is called allometric conversion. For example, when there are available toxicological data and dose levels for mice, but toxicity data and dose levels are needed for the rat, an allometric conversion estimates a similar dose level for the fox. The underlying assumption of allometric conversions is that a given effect on a species of small mammals is similar to the effect on a larger species of mammals, per unit body weight. Although several allometric conversion equations are available in the literature, Sample and Arenal (1999) is used for conversion of mammalian TRVs:

$$\text{Dose}_{\text{receptor}} = \text{Dose}_{\text{test organism}} \left(\text{Body Weight}_{\text{test organism}} / \text{Body Weight}_{\text{receptor}}\right)^{0.06}$$

The equation from Mineau, et al. (1996) is used for conversion of avian TRV's:

$$\text{Dose}_{\text{receptor}} = \text{Dose}_{\text{test organism}} \left(\text{Body Weight}_{\text{test organism}} / \text{Body Weight}_{\text{receptor}}\right)^{-0.14}$$

Allometric equations generally follow the form:

$$Y = aM^{b}$$

Y is some variable of structure or function and is dependent (following a power law equation) on body mass, *M*, and *a* and *b* are taxon-specific empirical factors. Weight-specific metabolism in mammals scales with an exponent of 1/3, while biological rates (for example, respiratory rate) generally scale with an exponent of –1/4. In a review by Sample and Arenal (1999), the scaling factor for mammal toxicity was revised to 0.06 (1-0.94).

Mineau et al. (1996) showed that use of mammal-derived scaling factors underestimated the toxicity of a COPEC in birds, especially small birds. Based on empirical data from 10 species of birds and 37 chemicals, an average scaling factor of 1.14 is estimated for birds. However, scaling factors for the majority of chemicals evaluated (29 of 37) were not significantly different from 1. A scaling factor of 1 was therefore considered most appropriate for interspecies extrapolation among birds. Lindstedt (1987, in Mineau et al. 1996) notes that "throughout toxicology and the issues related to interspecies extrapolation, dose and exposure are nearly always "fixed" and are independent of both body mass and physiological time." For this reason, the allometric conversion proposed in Sample et al. (1996), based on weight-specific metabolism, is recommended.

When extrapolating bird toxicity from mammalian study results, only an uncertainty factor of 10 is applied and there is no adjustment for size.

Final TRVs used in the SERA for mammals and birds are presented in Appendix L4. Calculation of the HQs from the TRVs using the exposure assumptions of the representative species is presented in Appendix L5.

8.3 SERA Process - Tier 1, Step 2 – Exposure Estimation and Risk Characterization

This section presents the methods and results of Tier 1, Step 2 of the SERA process. This step comprises a quantitative risk analysis, with the potential for adverse effects to ecological receptors being estimated using very conservative assumptions. This section is divided into five subsections: exposure estimation (Section 8.3.1); risk calculations (Section 8.3.2); uncertainty analysis (Section 8.3.3); risk characterization (Section 8.3.4); and Tier 1, Step 2 exit criteria (Section 8.3.5).

Figure 8-4. Conceptual Site Model for Anomaly Area 3 and Agua Chinon Wash Surface Soil (0-6 ft bgs)

Contributing Sources	Transport Mechanisms	Exposure Route	Terrestrial Ecological Receptors[1]	Rationale
Surfce Soil (0-6 ft bgs)	Windborne Particulates	Inhalation of Fugitive dust Particulates	Insignificant	Inhalation of contaminated dust is expected to be insignificant because the site is well vegetated and dust generation is minimal.
	Volatilization	Inhalation of VOCs	Incomplete	VOCs may volatilize into soil air spaces from soil and migrate to the soil surface where they may be emitted to the atmosphere, exposing all receptors. However, VOCs were not detected in the soil column therefore, this exposure pathway is considered incomplete.
	Direct Contact	Dermal Absorption	Insignificant	Dermal absorption of surface soil contaminants is potentially complete for ecological receptors, but scientific data to estimate exposure of wildlife is lacking, so the pathway is not evaluated quantitatively. Soil invertebrates ingested as food by wildlife are assumed to take up soil COPECs through the skin. Exposure to COPECs by dermal absorption by wildlife is expected to be insignificant compared to exposure by ingestion pathways.
		Incidental Ingestion of Soil	**Potentially Complete**	Terrestrial wildlife are expected to incidentally ingest surface soil as part of normal feeding activities, therefore, this pathway is considered complete and is evaluated quantitatively. Also, burrowing mammals may contact surface soil (0-6 feet bgs), although the majority of exposure to COPECs is through ingestion of food.
	Bio-uptake	Ingestion of Plants/Animals (bio-uptake)	**Potentially Complete**	Terrestrial wildlife ingest plant parts (i.e., leaves, seeds, roots) and soil invertebrates that may have taken up COPECs from the soil into their body tissues, therefore, ingestion of contaminated food is considered a complete exposure pathway and is evaluated quantitatively.
Subsurface Soil (> 6 feet bgs)	Direct Contact	Dermal Absorption; Incidental Ingestion	Incomplete	Burrowing mammals may contact subsurface soils although the majority of exposure to COPECs is through ingestion of food.

(1) Future conditions are assumed to be similar to current conditions for ecological receptors. No future scenarios are run.

Figure 8-5. Conceptual Site Model for Anomaly Area 3 and Agua Chinon Wash Sediment and Surface Water

				Ecological Receptor		
Pathway	Contributing Sources	Transport Mechanisms	Exposure Route	Aquatic Organisms	Terrestrial riparian species	Rationale
Surface Water Runoff to Agua Chinon Wash	Wash Sediment	Direct Contact	Incidental Ingestion of Sediment	**Complete**	**Complete**	Benthic organisms may live within or on bottom sediments of Agua Chinon Wash so that it is not possible to separate exposure by ingestion of food or sediment and dermal/gill contact. These exposure pathways are lumped together into total "uptake" for risk evaluation. Benthic organisms are limited due to brief time surface water is available, so sediment chemicals are compared to soil screening levels for. Terrestrial riparian species may be exposed to COPECs in dry sediments throughout most of the year.
			Dermal Contact with Sediment	**Complete**	Potentially complete but not evaluated	Benthic organisms live within or on bottom sediments so that it is not possible to separate exposure by ingestion of food or sediment and dermal/gill contact. These exposure pathways are lumped together into total "uptake" for risk evaluation. Scientific information needed to assess dermal uptake in terrestrial ecological receptors is lacking but exposure is expected to be insignificant compared to food-chain pathways.
			Ingestion of Plants/Animal (bio-uptake)	Insignificant	**Complete**	Terrestrial riparian species may eat food that has taken up COPECs from sediment in Agua Chinon Wash.
Surface Water	Runoff from Surface Soil	Overland Flow	Uptake from Surface Water	**Complete**	Insignificant	Aquatic organisms may live in the ephemeral surface water of Agua Chinon Wash so that it is not possible to separate exposure by ingestion of water and dermal/gill contact. These exposure pathways are lumped together into total "uptake" for risk evaluation. Although water does not normally persist in the wash long enough to support an aquatic community it is screened against chronic water quality criteria. Water is not available for terrestrial species to drink for a long enough period to be a significant exposure concern.

8.3.1 Exposure Estimation

Exposure of representative species occurs in different ways, depending on the physical and behavioral characteristics of the organism. Plants take up COPECS from the soil by absorption through the roots. Soil invertebrates can be exposed by absorption across the skin and through ingestion of soil. The two mechanisms cannot be conveniently separated; therefore, soil invertebrate exposure (represented by the earthworm) is considered the combined uptake. Some COPECs must be dissolved in pore water before they can cross cell membranes into a plant root or an invertebrate's body. Terrestrial organisms can be exposed through the skin, respiratory surface, or, more commonly, through ingestion of contaminated soil and food.

EPCs are used in the exposure estimation and represent the maximum detected concentration in each affected medium at AA 3. The EPCs are summarized in Tables 8-1, 8-2, and 8-3.

8.3.2 Risk Calculations

The integration of toxicity and exposure information is used to predict possible adverse effects to ecological receptors. The HQ method is used to screen site COPECs for their potential to cause adverse effects to ecological receptors.

8.3.2.1 Hazard Quotients

The HQ method is used to compare media COPEC concentrations to media-specific, risk-based screening values. For plants and invertebrates, the HQ value is calculated by dividing the maximum surface soil COPEC concentration by the EcoSSLs or ORNL Soil Benchmark concentration. For surface water, the HQ value is calculated by dividing the maximum surface water COPEC concentration by the NRWQC values for the protection of aquatic life (EPA 2002c). If NRWQC values were not available, Great Lakes Tier II values presented in Suter II and Tsao (1996) were used as secondary values.

For soil, the HQ value is calculated using Equation 1:

Equation 1: Hazard Quotient

$$HQ = \frac{Intake\ of\ COPEC\ (mg/kg/day)}{TRV\ \ for\ COPEC\ (mg/kg/day)}$$

Where:

HQ = The hazard quotient.
Intake = Sum of chronic daily intake from all ingestion pathways (i.e., soil, plants and invertebrates)

Sediment samples were collected at the bottom of Agua Chinon Wash. The wash is ephemeral and benthic organisms are not present. Therefore, maximum concentrations of sediment COPECs were evaluated using terrestrial receptors to evaluate potential risk. The HQ method described above for soil exposure is also used to evaluate potential risk to terrestrial receptors exposed to dry sediment.

HQ values were determined for each COPEC and receptor at the site. HQ values equal to or exceeding 1 indicate that the exposure level equals or exceeds the effects level and that the receptor being assessed has a potential for adverse effects resulting from exposure to site contaminants via a variety of pathways at a given site. HQ values exceeding 1 do not necessarily indicate that an effect will occur, only that a lower threshold has been exceeded based on the exposure assumptions used in the model. It should be noted that a single chemical or pathway may be responsible for the majority of the risk to a receptor at a site.

Note that the HQ calculated using NOAEL-based TRVs provides some insight into general effects on individual animal reproduction and/or survival in the local population. It is assumed that if risks are judged insignificant for the average individual receptor, they will be considered insignificant at the population level. However, if risks are present at the individual receptor level, risks may or may not be important at the population level.

HQ values calculated for soil and sediment COPECs at AA 3 evaluated in the SERA are presented in the tables in Appendix L5 for each exposure pathway for each representative species. The COPECs include VOCs, SVOCs, PAHs, metals, and dioxins. The conservative exposure assumptions included use of maximum COPEC concentrations, minimum body weight, maximum ingestion rate, and a SUF of 1 (see Table 8-6 and Appendix L5).

8.3.2.2 Comparison of Surface Soil COPEC Concentrations with Plant and Invertebrate Screening Concentrations

The comparison of COPECs found in surface soil at AA 3 with the plant and invertebrate screening concentrations developed for lower trophic level species in this assessment is summarized in Table 8-7. Maximum surface soil concentrations of aluminum, chromium, selenium, vanadium, and zinc exceed plant and invertebrate screening concentrations. These concentrations result in an HQ greater than 1, which indicates a potential for adverse effects to lower trophic level ecological receptors.

Two VOCs, fourteen SVOCs, and dioxins detected in surface soil did not have plant and invertebrate screening concentrations. The potential risks posed by certain SVOCs and dioxins are unknown for plants and invertebrates due to the lack of relevant effects levels.

Table 8-7: Comparison of Maximum Soil EPCs with Plant and Invertebrate Screening Concentrations

COPEC	Maximum Concentration (mg/kg)	ORNL Soil Benchmark [1] (mg/kg)	Hazard Quotient
VOCs			
Acetone	0.100	DG	—
Methylene chloride	0.0092	DG	—
SVOCs			
Anthracene	0.044	DG	—
Benzo(a)anthracene	0.73	DG	—
Benzo(a)pyrene	1.03	DG	—
Benzo(b)fluoranthene	1.79	DG	—
Benzo(g,h,i)perylene	0.44	DG	—
Benzo(k)fluoranthene	0.51	DG	—
Bis(2-Ethylhexl)phthalate	0.07	DG	—
Chrysene	0.87	DG	—
Dibenz(a,h)anthracene	0.097	DG	—
Diethyphthalate	0.225	100	2E–03
Fluoranthene	1	DG	—
Hexachlorobenzene	0.15	DG	—
Indeno(1,2,3-cd)pyrene	0.46	DG	—
Phenanthrene	0.29	DG	—
Phenol	0.936	30	3E–02

Table 8-7: Comparison of Maximum Soil EPCs with Plant and Invertebrate Screening Concentrations

COPEC	Maximum Concentration (mg/kg)	ORNL Soil Benchmark (1) (mg/kg)	Hazard Quotient
Pyrene	0.96	DG	—
Metals			
Aluminum	15,800	50	**3E+02**
Antimony	2.1	78	3E–02
Arsenic	4.63	10	5E–01
Barium	187	329	6E–01
Beryllium	0.31	40	7E–03
Cadmium	1	28	4E–02
Chromium	15.8	0.4	**4E+01**
Cobalt	7.6	32	2E–01
Copper	10.8	50	2E–01
Lead	20.7	210	**1E-01**
Manganese	289	500	4E–01
Mercury	0.069	0.1	7E–01
Nickel	13.7	30	5E–01
Selenium	1.1	1	**1E+00**
Silver	2	2	1E+00
Vanadium	44.1	2	**2E+01**
Zinc	57.1	50	**1E+00**
Dioxins			
Total 2,3,7,8-TCDD (Mammal)[2]	0.0000184	DG	—
Total 2,3,7,8-TCDD (Bird)[2]	0.0000353	DG	—

NOTES:
COPEC = chemical of potential ecological concern
mg/kg = milligrams per kilogram
DG = data gap; screening value not available
Values in bold indicate that COPEC concentration exceeds surface soil screening criteria for lower trophic level organisms; HQ is equal to or greater than 1.
— = not evaluated due to data gaps.
[1] = The lesser of plant screening value (Efroymson et al. 1997a) or soil invertebrate screening value (Efroymson et al. 1997b). Eco-SSL used for antimony, barium, beryllium, cadmium, cobalt, and lead.
TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
TEQ = Toxicity equivalent quotient
TEF = toxicity equivalency factor
[2] TEQ value calculated based on TEFs for birds and mammals respectively.

8.3.2.3 *Tier 1 Surface Soil Risk Calculation Results*

The HQ results of risk calculations based on food chain exposure and conservative exposure assumptions for surface soil COPECs are presented in Appendix L5-1 through L5-6. Those receptors with elevated HQs (equal to or greater than 1) are presented in Table 8-8.

The HQs for aluminum, antimony, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, and total 2,3,7,8-TCDD (mammal) and (bird) are 1 or greater, with respect to specific receptors, which indicates a potential for adverse effects to terrestrial ecological receptors.

Table 8-8: Elevated Hazard Quotient Values for Soil COPECs

COPEC	Ornate Shrew	Deer Mouse	Long-tailed Weasel	Mourning Dove	Western Meadow-lark	Red-shouldered Hawk
Metals						
Aluminum	1E+03	3E+01	9E+01	—	1E+01	—
Antimony	1E+01	—	—	2E+00	8E+01	1E+00
Beryllium	—	—	—	—	1E+00	—
Cadmium	5E+00	—	—	—	1E+00	—
Chromium	—	—	—	—	2E+00	—
Cobalt	—	—	—	—	1E+00	—
Copper	1E+00	—	—	—	1E+00	—
Lead	—	—	—	—	1E+00	—
Mercury	—	—	—	—	2E+00	—
Nickel	14E+01	1E+00	1E+00	—	1E+01	—
Selenium	9E+00	2E+00	—	—	12E+00	—
Vanadium	1E+01	—	—	—	—	—
Zinc	1E+01	—	—	—	4E+00	—
Dioxins						
Total 2,3,7,8-TCDD (Mammal)[1]	2E+01	—	—	NA	NA	NA
Total 2,3,7,8-TCDD (Bird)[1]	NA	NA	NA	—	3E+00	—

NOTES:
COPEC = chemical of potential ecological concern
— = HQ is less than 1 for this receptor
TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
TEQ = Toxicity equivalent quotient
TEF = toxicity equivalency factor
[1]TEQ value calculated based on TEFs for birds and mammals respectively.

8.3.2.4 Tier 1 Sediment Screening Risk Calculation Results

The HQ results of risk estimates for terrestrial wildlife based on conservative exposure assumptions for sediment COPECs, are presented in Appendix L6-1 through L6-6. Those receptors with HQs equal to or greater than 1 are presented in Table 8-9.

The HQs for aluminum, cadmium, chromium, mercury, nickel, selenium, vanadium, and zinc in sediment are 1 or greater with respect to their specific receptors, which indicates a potential for adverse effects to terrestrial ecological receptors.

Table 8-9: Elevated Hazard Quotient Values for Sediment COPECs

COPEC	Ornate Shrew	Deer Mouse	Long-tailed Weasel	Mourning Dove	Spotted Towhee	Red-shouldered Hawk
Metals						
Aluminum	1E+02	5E+00	3E+01	—	3E+00	1E+01
Cadmium	3E+00	—	—	—	—	—
Chromium	—	—	—	—	3E+00	—
Mercury	—	—	—	—	2E+00	—
Nickel	2E+01	—	—	—	6E+00	—

Table 8-9: Elevated Hazard Quotient Values for Sediment COPECs

COPEC	Ornate Shrew	Deer Mouse	Long-tailed Weasel	Mourning Dove	Spotted Towhee	Red-shouldered Hawk
Selenium	4E+00	—	—	—	1E+00	—
Vanadium	1E+00	—	—	—	—	—
Zinc	4E+00	—	—	—	3E+00	—

NOTES:
COPEC = chemical of potential ecological concern
— = HQ is less than 1 for this receptor

8.3.2.5 Comparison of Surface Water EPCs with Surface Water Screening Criteria

Comparisons of surface water EPCs concentrations with surface water screening criteria are presented in Table 8-10. Eleven metals (aluminum, barium, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, vanadium, and zinc) exceed their surface water screening values.

Table 8-10: Comparison of Surface Water EPCs with Surface Water Benchmark Concentrations

COPEC	NRWQC (µg/L)	Great Lakes Tier II Criteria (µg/L)	Exposure Point Concentration (µg/L)	Hazard Quotient
Metals				
Aluminum[(1)]	87	NA	87500	**1E+03**
Arsenic	150	NA	34.2	2E–01
Barium	NA	4	871	**2E+02**
Beryllium	NA	0.66	2.7	**4E+00**
Cadmium	0.25	NA	6.4	**3E+01**
Chromium[(2)]	11	NA	83.5	**8E+00**
Cobalt	NA	23	31.5	**1E+00**
Lead	2.5	NA	28.2	**1E+01**
Manganese	NA	120	1070	**9E+00**
Nickel	52	NA	78.5	**2E+00**
Vanadium	NA	20	227	**1E+01**
Zinc	120	NA	286	**2E+00**

NOTES:
COPEC = chemical of potential ecological concern
NRWQC = National Recommended Water Quality Criteria (EPA 2002c)
DG = data gap, screening value not available
µg/L = micrograms per liter
Values in **bold** indicate that COPEC concentration exceeds surface water screening criteria for the protection of aquatic life; HQ exceeds 1.
[(1)] Freshwater chronic criterion for aluminum, 87 µg/L, is used. It is based on pH=6.5-9 in groundwater. EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg/L of aluminum, when either total recoverable or dissolved is measured (EPA 1998b).
[(2)] NRWQC value for chromium VI used.

8.3.3 Uncertainty Analysis

Ecological risk assessment results depend primarily on the weight of evidence supporting particular conclusions, and each line of evidence is subject to varying degrees of uncertainty. Due to the complexity of ecosystems and the associated mechanisms that cause ecological stress, uncertainty in environmental risk characterization is inevitable. Uncertainty stems from a number of sources. These include, but are not limited to, the following:

- Sampling and statistical variability
- Limitations of toxicity testing
- Difficulty of extrapolating from laboratory data to field data
- Problems in evaluating environmental responses to mixtures of contaminants
- Assumptions underlying the use of fate and transport models
- Range of conditions for which models or hazard indexes are applicable

Other uncertainty sources include unexpected weather conditions or sources of contamination. Uncertainty associated with each step of this ecological risk characterization is described below.

8.3.3.1 Uncertainties in the Ecological Exposure Estimation

A number of chemicals in surface soil, sediment, and surface water had reporting limits that were higher than their respective ecological screening values that may potentially underestimate risk for these analytes.

8.3.3.2 Uncertainties in the Ecological Toxicity Assessment

A variety of sources of uncertainty were not included above. For one, it has long been recognized that laboratory studies referenced as a basis for generating TRVs may not accurately represent the complexities of potential exposure under field conditions. For example, the dosing of test animals by use of highly soluble salts in drinking water may overestimate exposures compared with the same salt administered in food. The chemical form present at the site may be in a less soluble form than that used in the laboratory study (e.g., lead acetate in water compared to lead carbonate in food). Finally, toxicological studies on which TRVs are based deal with a single chemical; effects of simultaneous exposure to multiple contaminants were not addressed.

Dioxin congeners were evaluated on the basis of toxicity equivalence (TEQ) relative to 2,3,7,8-tetrachlorodibenzo-n-dioxin (TCDD). The EPA has assigned TEFs relative to 2,3,7,8-TCDD for highly chlorinated dibenzo-n-dioxins (CDDs) and highly chlorinated dibenzo-n-furans (CDFs). The maximum concentration of each detected dioxin congener and the full reporting limit of each non-detected dioxin congener was multiplied by the congener-specific TEF for birds to calculate 2,3,7,8-TCDD TEQs. Van den Berg et al. (1998) pointed out that the TEFs developed for birds are normally applied to bird tissue concentrations to estimate a tissue burden of 2,3,7,8 TCDD. However, they can also be used as a surrogate to estimate an ingested dose when applied to diet concentrations (EPA 2003b). This application adds a level of uncertainty to the estimation of bird dioxin exposure. Because mammal TEFs are based on diet exposure, the TEFs for mammals are applied directly to each diet fraction to estimate a diet-based TEQ for mammals.

To calculate the expected bioaccumulation of dioxins in the plant and earthworm, congeners were summed and a surrogate BCF, based on 2,3,7,8-TCDD, was used to estimate dioxin uptake. Since dioxins are comprised of several congeners, each of which may bioaccumulate at a unique rate, the use of the 2,3,7,8-TCDD BCF to represent all congeners may over- or under-estimate total dioxins in the diet.

8.3.3.3 Uncertainty in the Hazard Quotient Method

The use of HQs for the assessment of risk presents some level of uncertainty. Primarily, calculation of an HQ is based on exposure modeling and development of TRVs, two exercises that have uncertainty in and of themselves. Although the endpoints measured in most toxicological studies used to generate TRVs were the same (development/reproduction/survival), the effects of simultaneous exposure to multiple contaminants may be, for example, synergistic or antagonistic (i.e., not necessarily additive). Thus, HQ values for specific chemical, receptor, and pathway combinations are absent. This potentially contributes to underestimating the HQ values for the pathway and, consequently, the HQ for the receptor from all pathways.

8.3.4 Risk Characterization

The results of the Tier 1, Step 2 risk estimates indicate that twelve metals and dioxins (mammal and bird) in surface soil, eight metals in sediment, and eleven metals in surface water at AA 3 may cause adverse effects to terrestrial ecological receptors and aquatic life.

8.3.4.1 Surface Soil

Five of the maximum soil concentrations for analytes that have HQs of one or greater (including cadmium, chromium, copper, vanadium, and zinc) were detected in the surface soil sample collected at HA22, located in the north-central portion of AA 3 (see Figure 4-1 for locations). The maximum surface soil concentrations of total 2,3,7,8-TCDD (mammal and bird) were also detected in the north-central portion of AA 3, at HA26 (see Figure 4-1 for locations).

Locations of the remaining maximum detected concentrations of metals in soil that had HQs of 1 or greater were located in soil samples HA01 (antimony), HA03 (mercury), HA04 (lead), HA19 (selenium), HA23 (beryllium), and HA28 (aluminum) (see Figure 4-1 for locations).

The maximum soil concentration for one metal (nickel), which has an HQ greater than 1 was detected in trench sample AA3-2E-01 (see Figure 4-1 for locations).

8.3.4.2 Sediment

The maximum concentrations of aluminum, cadmium, chromium, mercury, nickel, vanadium, and zinc were detected in the upgradient sediment sample LK289 (see Figure 4-1 for locations) had HQs of 1 or greater.

The maximum concentration of selenium, detected in the down gradient sediment sample (LK292) (see Figure 4-1 for location), had HQs of 1 or greater.

8.3.4.3 Surface Water

Of the twelve metals detected in the surface water, eleven have HQs of 1 or greater. These include aluminum, barium, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, vanadium, and zinc. These metals were also detected in the down gradient surface water sample LK287, (see Figure 4-1 for location). The maximum concentration of aluminum in surface water was detected in the upgradient surface water sample LK286. Beryllium and manganese were detected at the same concentration at the down gradient (LK287) and upgradient location (LK286) (see Figure 4-1 for locations).

The majority of the flow through the wash is from residential runoff upgradient of the site that is the likely source of (non-point source) chemicals in the surface water. Because the flow in the wash is ephemeral, there is no aquatic community present in the area. Sites down gradient will receive a relatively small proportion of their water from the AA 3 footprint. The surface water concentrations of the eleven metals with HQs of 1 or greater in the down gradient location also have concentrations that exceed the screening criteria in the upgradient location, indicating that runoff from upgradient could likely be the contributing source of potential risk to aquatic life. Therefore, the effect of runoff from AA 3 on down gradient aquatic communities is expected to be minimal.

8.3.5 Tier 1, Step 2 Exit Criteria

Three outcomes are possible at this point in the SERA:

- There is adequate information to conclude that the ecological risks are negligible and therefore there is no need for further evaluation or remediation on the basis of ecological risk;
- The information is not adequate to make a decision at this point, and the ERA process will continue to Step 3; or
- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

8.3.6 Summary, Conclusions, and Recommendations of Tier 1 SERA

8.3.6.1 Summary and Conclusions

8.3.6.1.1 Plants and Invertebrates

The maximum soil concentrations of aluminum, chromium, selenium, vanadium, and zinc exceed plant and invertebrate screening concentrations (ORNL soil benchmark). These concentrations result in HQs of 1 or greater, which indicate a potential for adverse effects to lower trophic level ecological receptors. Two VOCs, fourteen SVOCs and dioxins detected in surface soil did not have ORNL soil benchmark concentrations.

8.3.6.1.2 Bird and Mammal Receptors

The maximum soil concentrations of aluminum, antimony, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium, zinc, and total 2,3,7,8-TCDD (mammal and bird) result in HQ values equal to or greater than 1, which indicate a potential for adverse effects to terrestrial mammal and bird receptors at AA 3 that forage in the mulefat scrub habitat.

The maximum sediment concentrations for aluminum, cadmium, chromium, mercury, nickel, selenium, vanadium and zinc result in HQs of 1 or greater, which indicate a potential for adverse effects to terrestrial mammal and bird receptors at AA 3.

8.3.6.1.3 Aquatic Life

The maximum surface water concentrations of aluminum, barium, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, vanadium, and zinc exceed surface water screening concentrations (NRWQC or Great Lakes Tier II values). These concentrations result in HQs of 1 or greater, which indicate a potential for adverse effects to aquatic organisms at AA 3.

8.3.6.2 COPECs Retained for Tier 2, Step 3a BERA

Table 8-11 presents the list of COPECs that are retained after the SERA because HQ values are 1 or greater in their respective media.

Table 8-11: COPECs for Tier 2, Step 3a – BERA List 1

COPEC	Hazard Quotient Values Equal to or Greater than 1		
	Surface Soil	Sediment	Surface Water
Metals			
Aluminum	X	X	X
Antimony	X	NA	NA
Barium	–	–	X
Beryllium	X	NA	X
Cadmium	X	X	X
Chromium	X	X	X
Cobalt	–	–	X
Copper	X	–	NA
Lead	X	–	X
Manganese	–	–	X
Mercury	X	X	NA
Nickel	X	X	X
Selenium	X	X	NA
Vanadium	X	X	X
Zinc	X	X	X
Dioxins			
Total 2,3,7,8-TCDD (Mammal)[1]	X	NA	NA
Total 2,3,7,8-TCDD (Bird)[1]	X	NA	NA

Notes:
COPEC = chemical of potential ecological concern
X = HQ is 1 or greater for noted COPEC and medium
NA = Analyte is not a COPEC in this medium
–= HQ value did not exceed 1 for COPEC in this medium
TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
TEQ = Toxicity equivalent quotient
TEF = toxicity equivalency factor
[1] TEQ value calculated based on TEFs for birds and mammals respectively.

Table 8-12 presents the list of COPECs that are retained after the SERA because their maximum reporting limit ranges exceed their respective screening criteria in at least one sample.

Concentrations of twelve metals and dioxins (mammal and bird) in surface soil, eight metals in sediment, and eleven metals in surface water have HQ values equal to or greater than 1. Therefore, the site fails the SERA and soil, sediment, and surface water pathways require further evaluation in a BERA.

As mentioned in Section 8.1.2 and shown in the flowchart of Figure 8-2, there are three possible outcomes (exit criteria) after screening the site in accordance with Steps 1 and 2 of Tier 1 SERA. Since the SERA indicated risks to plant, invertebrate, and terrestrial receptors using conservative screening values and had associated uncertainties, the outcome of the Tier 1 was that the information evaluated in Tier 1, Steps 1 and 2 (SERA) is not sufficient to make a decision, and the ERA process for the site will continue to Tier 2, Step 3a (BERA).

Table 8-12: COPECs for Tier 2, Step 3a – BERA List 2

COPEC	COPECs with Maximum Reporting Limit Ranges > Screening Criteria		
	Surface Soil	Sediment	Surface Water
Metals			
1,2,4-Trichlorobenzene	X	NA	NA
1,4-Dichlorobenzene	X	NA	NA
2,4-Dinitrophenol	X	NA	NA
4-Nitrophenol	X	NA	NA
Copper	–	–	X
Hexachlorocyclopentadiene	X	NA	NA
Molybdenum	X	NA	NA
Pentachlorophenol	X	NA	NA
Thallium	X	NA	NA

NOTES:
COPEC = chemical of potential ecological concern
X = maximum reporting limit exceeds screening value
NA = Analyte is not a COPEC in this medium
- = maximum reporting limit range did not exceed screening value

8.3.6.3 Recommendations

Based on the qualitative and quantitative results of the SERA, it is recommended that the COPECs listed in Tables 8-11 and 8-12 be retained as COPECs and evaluated in a Tier 2, Step 3a BERA (Section 8.4).

8.4 BERA Process – Tier 2, Step 3A

8.4.1 Introduction

The SERA for AA 3 is presented in Sections 8.2 and 8.3, and includes Tier 1, Steps 1 and 2. These steps were conducted in accordance with the EPA guidance (EPA 1997b), U.S. Navy ERA guidelines (DoN 1999), and the Final RSE work plan (Earth Tech 2002a).

Refer to the Step 1 procedures in Section 8.2 for the ecological site description, COPECs, as well as assessment endpoints, measurement endpoints, representative species, exposure pathway analysis, the development of a CSM, and toxicity evaluation. Refer to Step 2 procedures in Section 8.3 for exposure estimations and screening level risk characterization.

The BERA Tier 2, Step 3a uses the same representative species, exposure pathways, and TRVs, with refined exposure assumptions to more accurately estimate the potential risk to ecological receptors from COPECs that failed the conservative Tier 1 screening process. NOAEL-based TRVs are retained in this BERA because endangered birds may occasionally utilize part of the site for foraging, and NOAEL—based TRVs are protective at the individual level.

8.4.2 Overview of Tier 2, Step 3a BERA Process

The Tier 2 ERA represents the BERA and follows a five-step process to evaluate ecological risks and to determine if site remediation is warranted from an ecological perspective. The five steps that make up Tier 2 (Steps 3 through 7) are consistent with and analogous to Steps 3 through 7 of the EPA Superfund process for ERA. The Tier 2 BERA includes 2 sets of decision criteria (Step 3a and Step 7) for exiting from or proceeding with the ERA process.

The dual objectives of Tier 2, as specified in the Navy ERA policy, are to address risk management and decision-making considerations, and to identify assessment objectives to avoid multiple iterations of the BERA. The purpose of Tier 2, Step 3a is to reevaluate COPECs that were retained from Tier 1 for further evaluation in a Tier 2 BERA and to identify and eliminate from further consideration those COPECs that were retained because of the use of very conservative exposure scenarios. Using less conservative (but more realistic) assumptions, the Tier 1 SERA risk estimates will be recalculated. These recalculated risk estimates will then be used to refine the list of COPECs identified in the Tier 1 SERA in order to remove some or all of the COPECs from further consideration. The Step 3a of Tier 2 questions that would help refine the Tier 1 SERA are

- Do site contaminant concentrations exceed background levels? (background risks)
- Are high concentrations and risks widespread across the site or limited to discrete locations? (magnitude and extent of contamination and risk)
- Could the COPEC be in a chemical form that is less hazardous? (bioavailability of the COPEC)

This Tier 2, Step 3a evaluation will involve the refinement of conservative exposure characteristics used in the SERA, including re-estimation of risk using HQs, use of 95% UCLs in place of maximum soil concentrations to represent exposure concentration, use of mean body weights and food ingestion rates, use of diet fractions typical of each representative species as identified in the literature, and comparison of concentrations of inorganics to background concentrations.

The Step 3a reevaluation/refinement process is the first step in the BERA problem formulation and will follow these steps (Navy ERA process):

- Revise exposure factor assumptions and recalculate doses and HQ risk estimates. This step may also include usage of 95 percent UCL value in place of maximum detected concentration.
- Identify COPECs with HQ less than 1.0 and eliminate from further evaluation.
- For COPECs with HQ greater than 1.0, compare maximum concentrations to background levels. Identify COPECs present at concentrations below background, and propose these for elimination from further evaluation.
- For COPECs with HQ greater than 1.0, examine detection frequency, identify COPECs with low detection frequencies (and sufficient data from acceptable site characterization), and propose these for elimination from further evaluation.
- For COPECs with HQ greater than 1.0, consider bioavailability, identify COPECs likely to be biologically unavailable, and propose these for elimination from further evaluation.

After the reevaluation/refinement, the decision criteria for Tier 2, Step 3a are

- If the re-evaluation of the conservative exposure assumptions used in the SERA supports an acceptable risk determination for all COPECs, then a no further action designation is warranted and the site *exits* the ERA process.
- If the re-evaluation of the conservative exposure assumptions does not support an acceptable risk determination and continues to indicate an unacceptable risk for at least 1 COPEC, then the site *continues* the BERA process at Step 3b.

Similar to Tier 1 SERA process, Tier 2 Step 3a utilizes existing data with additional information obtained primarily from existing literature. Additionally, Step 3a employs the same dose models and risk characterization methods as those used in the Tier 1, with changes to the values of some input parameters.

8.4.3 Tier 2, Step 3a – Refinement of Exposure Factors

8.4.3.1 Refinement of the COPEC List

All chemicals detected in soil (0 to 6 ft bgs), sediment, and surface water that exceeded screening values for plants and invertebrates, or had HQ values of 1 or greater for terrestrial ecological receptors or aquatic life, at AA 3 were retained for further evaluation in Tier 2, Step 3a of the BERA. Also, those chemicals whose maximum reporting limit ranges were greater than their respective screening values and were not detected in any sample of that particular medium were also retained for discussion in Tier 2, Step 3a. See Tables 8-11 and 8-12 of the SERA for the complete list of COPECs retained for further evaluation in Tier 2, Step 3a.

8.4.3.2 Refinement of Exposure Factors

The most conservative species-specific exposure factors were used to estimate Tier 1, Step 2 exposure. In Tier 2, Step 3a, more realistic exposure factors are substituted in the exposure equations (Table 8-13) and the resulting uptake or intake is divided by the TRV values to estimate the potential for adverse effects to ecological receptors expressed as HQs. More realistic exposure concentrations are used to calculate chemical-specific exposure factors (Appendix L7) based on the 95% UCL, if applicable. If the HQ exceeds 1, then there is a potential for adverse effects. Because the representative species are meant to represent endangered species, NOAEL-based TRVs are retained. Because the HQs are based on NOAELs, an HQ of 1 means that no effect is expected and the COPEC is dropped from further consideration.

8.4.3.3 Refinement of TRVs

Generally in a BERA, LOAEL–based TRVs can be used to reevaluate the potential for adverse effects to representative species. NOAEL based TRVs represent a no-effect level of exposure and protect species at the individual level. This is appropriate for assessing the risk to endangered species where every individual may contribute to the survival of the species and an adverse effect may result in death. LOAELs identify the lowest exposure at which an adverse effect may occur. It does not indicate that an adverse effect will occur, only that a lower threshold has been exceeded.

Individuals of a species do not exist in isolation from other members of the species, but instead exist as a member of a population that interacts with other plant and animal species in the area as a community. At the population level, an individual death is not important in maintenance of a healthy population (Odum, 1971). A population is sustained by a balance between a death rate (mortality) and a birth rate (natality). When the mortality exceeds natality the population size decreases. When natality exceeds mortality the population size increases. Normally a population responds to increased mortality by increasing natality through density-dependent population regulation mechanisms mediated through the endocrine system. LOAELs are used to estimate the potential for adverse effects at the population level. The calculation of HQs based on both LOAELs and NOAELs gives risk managers a risk range to consider in making risk management decisions for a site.

Table 8-13: Summary of BERA Species-Specific Exposure Factors

Factor	Value	Reference
Ornate shrew		
Mean body weight (kg)	0.0059	Brown et al. (1996)
Mean foraging area (ha)	0.22	Platt (1976) (for short-tailed shrew)
Mean Food intake (mg/d, dry wt)	1,119 [a]	Nagy (2001)
Water intake (mL/day)	1.0 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.0 (plant) 0.98 (animal)	Derived from DOI (2002)
Deer mouse		
Mean body weight (kg)	0.0196	Derived from Schlesinger and Potter (1974)
Mean foraging area (ha)	0.1	Bowers and Smith (1979)
Mean Food intake (mg/d, dry wt)	3,322 [a]	Nagy (2001)
Water intake (mL/day)	2.9 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.49 (plant) 0.49 (animal)	Derived from EPA (1993)
Long-tailed weasel		
Mean body weight (kg)	0.265	Derived from Baker (1983)
Mean foraging area (ha)	12	Burt and Grossenheider (1976)
Mean Food intake (mg/d, dry wt)	16,058 [a]	Nagy (2001)
Water intake (mL/day)	30 [b]	EPA (1993)
Diet Partition Factor	0.03 (soil)	Beyer et al (1994), similar to fox
	0.00 (plants) 0.97 (animals)	Derived from Burt and Grossenheider (1976)
Western Meadowlark		
Mean body weight (kg)	0.094	Lanyon (1962)
Mean foraging area (ha)	3	Schoener (1968)
Mean Food intake (mg/d, dry wt)	14,038 [a]	Nagy (2001)
Water intake (mL/day)	12 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.36 (plant) 0.62 (animal)	Derived from Lanyon (1994)
Spotted towhee		
Mean body weight (kg)	0.0405	Clench and Leberman (1978)
Mean foraging area (ha)	3.8	Derived from Barbour (1941)
Mean Food intake (mg/d, dry wt)	7,893 [a]	Nagy (2001)
Water intake (mL/day)	6.9 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.24 (plants) 0.74 (animals)	Derived from Martin et al. (1961)
Mourning dove		
Mean body weight (kg)	0.119	Dunning (1993)
Mean foraging area (ha)	0.45	Schoener (1966)
Mean Food intake (mg/d, dry wt)	16,479 [a]	Nagy (2001)
Water intake (mL/day)	14 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)

Table 8-13: Summary of BERA Species-Specific Exposure Factors

Factor	Value	Reference
	0.98 (plants) 0.00 (animal)	Derived from Erlich et al., (1988)
Red-Shouldered Hawk		
Mean body weight (kg)	0.559	Hartman (1961)
Mean foraging area (ha)	36.8	McCrary (1982)
Mean Food intake (mg/d, dry wt)	56,291 [a]	Nagy (2001)
Water intake (mL/day)	40 [b]	EPA (1993)
Diet Partition Factor	0.02 (soil)	Derived from Beyer et al. (1994)
	0.00 (plants) 0.98 (animal)	Derived from Polite (2003)

NOTES:
kg = kilogram mg = milligram mL = milliliter
[a] Dry-weight food intake estimated based on algorithm in EPA guidance document (Nagy 2001).[b] Water intake estimated based on algorithm given in EPA (1993).

The proposed exposure refinements include the following:

- Assume SUF is the area of the contamination at the site divided by the species foraging area.
- Assume animal weight is the mean for the species.
- Assume food ingestion rate is the mean for the species.
- Use literature-derived diet fraction for incidental soil, plant, and soil invertebrate ingestion.
- Use 95 percent UCL of the mean to represent the upper limit average COPEC concentrations (if the 95% UCL is less than the maximum).

8.4.4 Risk Calculations

8.4.4.1 Soil

The HQ results of risk calculations based on more realistic exposure assumptions for soil COPECs are presented in Appendix L8 and summarized in Table 8-14 for receptors with HQs greater than 1.

Table 8-14: Tier 2, Step 3a, Hazard Quotient Values Greater than 1 for Soil COPECs after Tier 2, Step 3a BERA Calculations

COPEC	Ornate Shrew	Deer Mouse	Long-tailed Weasel	Mourning Dove	Western Meadowlark	Redshouldered Hawk
Metals						
Aluminum	4E+02	2E+02	1E+01	–	3E+00	–
Antimony	7E+00	3E+00	–	2E+00	3E+01	–
Beryllium	–	–	–	–	–	–
Cadmium	2E+00	–	–	–	–	–
Chromium	–	–	–	–		–
Copper	–	–	–	–	–	–
Lead	–	–	–	–	–	–
Mercury	–	–	–	–	–	–
Nickel	1E+01	1E+01	–	–	2E+00	–
Selenium	3E+00	2E+00	–	–	–	–

Table 8-14: Tier 2, Step 3a, Hazard Quotient Values Greater than 1 for Soil COPECs after Tier 2, Step 3a BERA Calculations

COPEC	Ornate Shrew	Deer Mouse	Long-tailed Weasel	Mourning Dove	Western Meadowlark	Redshouldered Hawk
Vanadium	5E+00	2E+00	–	–	–	–
Zinc	4E+00	3E+00	–	–	2E+00–	–
Dioxins						
Total 2,3,7,8-TCDD (mammal)	7E+00	3E+00	–	NA	NA	NA
Total 2,3,7,8-TCDD (bird)	NA	NA	NA	–	–	–

Notes:
COPEC = chemical of potential ecological concern
— = HQ is less than 1 for this receptor
NA = Analyte is not a COPEC in this medium

Aluminum, antimony, beryllium, cadmium, chromium, copper, lead, nickel, selenium, vanadium, zinc, and total 2,3,7,8-TCDD (mammal and bird) were further evaluated for potential risk because their HQ values were 1 or greater in Tier 1, Step 2 risk calculations.

The HQ values for aluminum, antimony, cadmium, nickel, selenium, vanadium, zinc, and 2,3,7,8-TCDD (mammal) in soil are greater than 1 for at least one receptor. Beryllium, chromium, copper, lead, mercury, and 2,3,7,8-TCDD (bird) have HQ values equal to or less than one with respect to all receptors.

Molybdenum, thallium, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, 2,4-dinitrophenol, 4-nitrophenol, hexachlorocylclopentadiene, and pentachlorophenol were also carried through to Tier 2, Step 3a because their respective maximum reporting limit ranges exceeded the soil screening value for ecological risk and could be underestimated. However, these COPECs were not detected in surface soil at the site; therefore, they cannot be further evaluated in Tier 2, Step 3a.

8.4.4.2 Sediment (Mulefat Scrub Habitat)

HQ results of risk calculations based on more realistic exposure assumptions for sediment COPECs are presented in Appendix L9. Table 8-15 presents the receptors with HQs greater than 1.

Aluminum, cadmium, chromium, mercury, nickel, selenium, vanadium, and zinc were further characterized for potential risk because their HQ values were 1 or greater in Tier 1, Step 2 risk calculations.

The HQ values for aluminum, cadmium, nickel, selenium, and zinc in sediment are greater than 1 for at least one receptor. Three metals in sediment, chromium, mercury, and vanadium, have an HQ value less than one with respect to all receptors.

Table 8-15: Hazard Quotient Values Greater than 1 for Sediment COPECs after Tier 2, Step 3a BERA Calculations

COPEC	Ornate Shrew	Deer Mouse	Long-tailed Weasel	Mourning Dove	Spotted Towhee	Red-shouldered Hawk
Metals						
Aluminum	7E+01	4E+01	6E+00	–	–	–
Cadmium	2E+00	–	–	–	–	–
Chromium	–	–	–	–	–	–

Table 8-15: Hazard Quotient Values Greater than 1 for Sediment COPECs after Tier 2, Step 3a BERA Calculations

COPEC	Ornate Shrew	Deer Mouse	Long-tailed Weasel	Mourning Dove	Spotted Towhee	Red-shouldered Hawk
Metals						
Mercury	–	–	–	–	–	–
Nickel	1E+01	8E+00	–	–	2E+00	–
Selenium	2E+00	2E+00	–	–	–	–
Vanadium	–	–	–	–	–	–
Zinc	2E+00	2E+00	–	–	–	–

Notes:
COPEC = chemical of potential ecological concern
— = HQ is less than 1 for this receptor

8.4.4.3 SURFACE WATER

Surface water risk calculations for Tier 2, Step 3a could not be refined because 95% UCL values were not available and more realistic exposure assumptions are not available.

Copper was also carried through to Tier 2, Step 3a because its respective maximum reporting limit range exceeded the surface water screening value for the protection of aquatic life and could be underestimated. However, this COPEC was not detected in surface water at the site; therefore, it cannot be further evaluated in Tier 2, Step 3a.

8.4.5 Background Screening

This step eliminates inorganic COPECs (inorganic COPECs retained after Tier 2, Step 3a (if HQ greater than 1) that are detected at concentrations less than or equal to concentrations found at background concentrations (BNI 1996) typical of uncontaminated soils. No organic preliminary COPECs in any medium, regardless of whether or not they may occur naturally, were screened out by this method; all were retained for further screening. Background screening was used only for inorganic COPECs in soil by first comparing each COPEC maximum concentration from site soil to background concentrations. Five inorganic chemicals in surface soil, including antimony, cadmium, nickel, vanadium, and zinc, do not exceed Station background concentrations (see Table 8-16).

Two metals, aluminum and selenium, have maximum detected soil concentrations that exceed their respective Station background concentrations. The 95% UCL for selenium also exceeds its background concentration at AA 3 (Table 8-16).

Table 8-16: Comparison of Maximum and 95% UCL COPEC Concentrations in Soils to Background Concentrations – Inorganic COPECs only

Metals	Maximum Detected Concentration (mg/kg)	95% UCL of the Mean (mg/kg)	Surface Soil Background Concentration* (mg/kg)	Maximum Detected Soil Concentration Exceeds Background?	95% UCL Concentration Exceeds Background?
Aluminum	15,800	10,200	14,800	**Yes**	No
Antimony	2.1	n/a	3.06	No	n/a
Cadmium	1	0.699	2.35	No	No
Nickel	13.7	8.28	15.3	No	No

Table 8-16: Comparison of Maximum and 95% UCL COPEC Concentrations in Soils to Background Concentrations – Inorganic COPECs only

Metals	Maximum Detected Concentration (mg/kg)	95% UCL of the Mean (mg/kg)	Surface Soil Background Concentration* (mg/kg)	Maximum Detected Soil Concentration Exceeds Background?	95% UCL Concentration Exceeds Background?
Selenium	1.1	0.543	0.32	**Yes**	**Yes**
Vanadium	44.1	28.1	71.8	No	No
Zinc	57.1	38.2	77.9	No	No

NOTES:
mg/kg = milligrams per kilogram
* BNI 1996. Final Technical Memorandum, Background and Reference Levels, Remedial Investigations. San Diego, CA.
n/a = Only one detection above reporting limit for this data set; therefore, the 95% UCL could not be computed and compared to the background concentration.

Background screening was also used for inorganic COPECs in sediment by comparing each COPEC maximum concentration from site sediment to site soil background concentrations. 95% UCL values were not available for sediment, so this comparison could not be made. All five chemicals, including aluminum, cadmium, nickel, selenium, and zinc do not exceed Station background concentrations (see Table 8-17).

Table 8-17: Comparison of Maximum and 95% UCL COPEC Concentrations in Sediment to Background Concentrations – Inorganic COPECs only

Metals	Maximum Detected Concentration (mg/kg)	Surface Soil Background Concentration* (mg/kg)	Maximum Detected Soil Concentration Exceeds Background?
Aluminum	3,050	14,800	No
Cadmium	0.26	2.35	No
Nickel	2.8	15.3	No
Selenium	0.17	0.32	No
Zinc	13.5	77.9	No

NOTES:
mg/kg = milligrams per kilogram
* BNI 1996. Final Technical Memorandum, Background and Reference Levels, Remedial Investigations. San Diego, CA.

8.4.6 Risk Characterization

8.4.6.1 Soil

The following five metals in soil, antimony, cadmium, nickel, vanadium, and zinc, have HQ values greater than 1 after the Tier 2, Step 3a risk calculations. However, their maximum soil concentrations (0 to 6 ft bgs) do not exceed Station background concentrations. Therefore, site activities did not result in a release of these metals that would cause adverse effects to terrestrial wildlife at AA 3.

The HQ exceedance of 1 for aluminum is based on an assumption of high bioavailability for birds and mammals. "EPA recognizes that due to the ubiquitous nature of aluminum, the natural variability of aluminum soil concentrations and the availability of conservative soil benchmarks…, aluminum is often identified as a contaminant of concern … for ecological risk assessments" (EPA 2000b). The toxicity of aluminum is associated with soluble aluminum while the analytical results used in this risk assessment are based on total extractable aluminum. The EPA recommends that aluminum be identified as a COPEC only for those soils with a pH less than 5.5. The technical basis for this is that the soluble and toxic forms of aluminum are only present in soil under soil pH values of less than 5.5 (EPA 2000b). For the surface soil samples collected at AA 3 site, the pH value ranged between 6.41 and 10.5. Therefore, it can be concluded that aluminum does not pose adverse effects to terrestrial wildlife at AA 3.

Uncertainty exists in the bioavailability of selenium. Risk (HQ=2) from selenium is being driven by invertebrate ingestion, which accounts for 81 percent of the total ingested dose for the deer mouse and 98 percent of the total ingested dose for the ornate shrew. The concentration of selenium in the soil invertebrates is estimated from soil concentration using a regression equation developed by Sample et al. (1998). The fit of the 13 data points to the line shows some variability, resulting in uncertainty of the predicted BCF. This may over- or under-estimate exposure and risk. Although, the maximum concentration and 95% UCL of selenium exceed the Station background concentration, in the western part of the U.S., soils have naturally high levels of selenium compounds (ATSDR 1994). In addition, since the background determination is a statistically based approach, it is not unexpected that a certain number of samples will exceed the 95th percentile yet still be within the true population or, in other words, still be indicative of naturally occurring concentrations. Since other metals at the site do not show signs of anthropogenic influence, the Station background concentrations may underestimate naturally high levels of selenium in soil at AA 3.

For 2,3,7,8-TCDD TEQ (mammal), the BERA risk calculations for the ornate shrew (HQ=7) and the deer mouse (HQ=3) are based on NOAEL-based TRVs. Since no endangered mammals are known from the area, a LOAEL-based TRV can be used to estimate a low-effect HQ to assess risk at the population level. The LOAEL-based HQ for the ornate shrew (HQ = 0.7) and the deer mouse (HQ = 0.3) are both below the point of departure of 1. This suggests that small mammal populations are not at risk from site dioxins, although certain individuals may be.

The bioavailability of dioxins in soil may also be overestimated. Large organic molecules such as dioxins bind tightly with organic matter found in natural soils and may not be generally bioavailable.

Finally, the BERA risk calculations of dioxins for the ornate shrew (HQ=7) and the deer mouse (HQ=3) are based on the 95% UCL (9.99 mg/kg) soil concentration. This value is driven by elevated concentrations detected in two out of eleven surface soil samples analyzed for dioxins, HA31 and HA26, located in the northwest corner of AA 3.

The HQ values for beryllium, chromium, copper, lead, mercury, and 2,3,7,8-TCDD (bird) in soil were 1 or less for all receptors; therefore, these COPECs do not present significant threats of adverse effects to wildlife at AA 3.

8.4.6.2 SEDIMENT

Eight metals in sediment that HQ values greater than 1 after the Tier 2, Step 3a risk calculations, including aluminum, cadmium, chromium, mercury, nickel, selenium, vanadium, and zinc. However, the maximum sediment concentrations of these metals do not exceed Station background soil concentrations. Therefore, these metals present a threat of adverse effect to wildlife that forage in the Agua Chinon Wash.

The HQ values for chromium, mercury, and vanadium in sediment was 1 or less for all receptors; therefore, these COPECs do not present a significant threat of adverse effects to wildlife at AA 3.

8.4.6.3 SURFACE WATER

Potential risk to aquatic life in surface water at AA 3 is indicated for the several COPECs in surface water. Aluminum, barium, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, vanadium, and zinc have HQs of 1 or greater. These were detected in the down gradient surface water sample (LK287). The maximum concentration of aluminum (HQ>1) in surface water was detected in the upgradient surface water sample LK286. Beryllium was detected at the same concentration at down gradient (LK287) and upgradient location (LK286).

However, evaluation of the ecological risk from other media suggests that anthropogenic activities have not had a negative effect on ecological receptors. In general, the concentrations of inorganic chemicals in Agua Chinon Wash where it enters the site via a culvert are nearly the same as concentrations in surface water leaving the site (at the foot bridge). This suggests that the presence of AA 3 has no effect on the water quality of the wash.

8.4.7 Conclusions of Tier 2, Step 3a BERA Process

In re-evaluating ecological risk based on refined exposure assumptions, the exposure of ecological receptors to selenium in surface soil at AA 3 may present a threat of adverse effects (HQ=2). This adverse effect is likely due to naturally high levels of selenium at the site. For 2,3,7,8-TCDD TEQ (mammal), the LOAEL-based HQ for the ornate shrew (HQ = 0.7) and the deer mouse (HQ = 0.3) are both below the point of departure of 1. This suggests that small mammal populations are not at risk from site dioxins, although certain individuals may be. The bioavailability of dioxins in soil may also be overestimated. Large organic molecules such as dioxins bind tightly with organic matter found in natural soils and may not be generally bioavailable. Risk managers should consider the risk range for the shrew and deermouse in making decisions regarding further action at the site.

Ecological risk from exposure to sediment at AA 3 does not present a significant threat of adverse effects to wildlife (based on refined exposure assumptions for sediment).

Although potential risk to aquatic life in surface water at AA 3 is indicated for the several COPECs in surface water, concentrations in COPECs in the upgradient and down gradient samples were similar, so AA 3 has not had an adverse impact on water quality in the Agua Chinon Wash. Therefore, evaluation of the ecological risk from other media suggests that anthropogenic activities have not had a negative effect on ecological receptors.